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MISSOURI BOTANICAL GARDEN BULLETIN

VOLUME XXIV

WITH 46 PLATES, 19 TEXT-FIGURES,
AND 1 MAP

1936

ST. LOUIS, MISSOURI

PUBLISHED MONTHLY EXCEPT JULY AND AUGUST,
BY THE BOARD OF TRUSTEES

SUBSCRIPTION PRICE:

ONE DOLLAR A YEAR SINGLE NUMBER TEN CENTS

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Vol. XXIV JANUARY, 1936 No. 1

CONTENTS

	Page
Forty-Seventh Annual Report of the Director	1
Statistical Information	42

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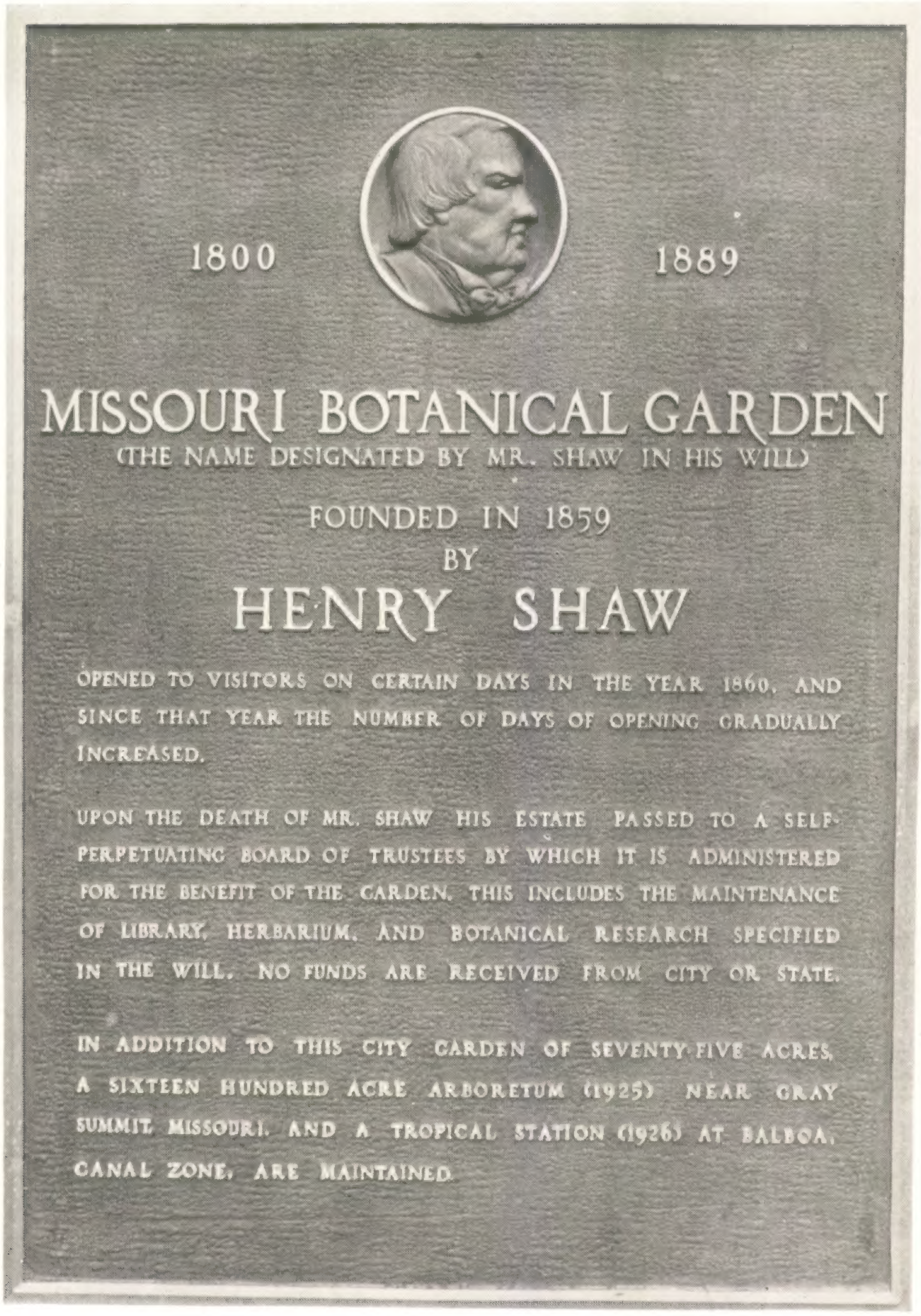


COMMEMORATIVE TABLET AT MAIN ENTRANCE TO THE GARDEN.
INSTALLED DECEMBER, 1935

Missouri Botanical Garden Bulletin

Vol. XXIV JANUARY, 1936 No. 1

FORTY-SEVENTH ANNUAL REPORT OF THE DIRECTOR

To the Board of Trustees:

The Director has the honor to submit his report for the year 1935, this being the forty-seventh annual report of the Garden.

Economies necessitated by a decreasing income are not immediately noticed by visitors to the Garden. The skimping of important features and the neglect of less obvious ones may be borne for a limited time without serious damage, but there comes a period when some matters can no longer be ignored without actual detriment or loss of prestige resulting. The year 1935 was such a period for the Garden. With no indication that the income could be materially increased above the low figure to which it fell in 1934 (see fig. 1, Mo. Bot. Gard. Bull. Jan. 1935), the Board of Trustees appropriated from accumulated savings an amount sufficient to provide certain necessary repairs as well as long-contemplated improvements. It is a pleasure therefore to enumerate some of the changes which this extra fund has made possible.

In anticipation of resurfacing the walks, an examination of the various drains carrying surface water became necessary. It developed that the drains were now so clogged that a normal rainy season flooded walks and surrounding lawns, although in previous dry years they had been adequate. In late April work was begun which finally included rebuilding the entire system. One hundred and four new catch basins, with an improved type of cover set in concrete boxes, were installed to replace 226 of the old-style drain-

tile basins. In the course of the work there was discovered an ancient rock sewer built at the time Mr. Shaw first laid out the Garden. This originally ran from the east end of what is now the rose garden, west to the creek near Alfred Ave. Buildings added in recent years necessitated cutting off this sewer at the floral display house and carrying it north under the coal bunkers to the main sewer. The operation was slow and difficult, since both the tile intakes and the sewer proper were half filled with roots, mud, and gravel. However, by the use of a tractor and drag line over twenty-four cubic yards of this material were finally removed.

In the latter part of July work was started on resurfacing the 2½ miles of hard walks. For the first time since they were built the walks in both the economic garden and medicinal garden have been water-proofed and the surface irregularities eliminated.

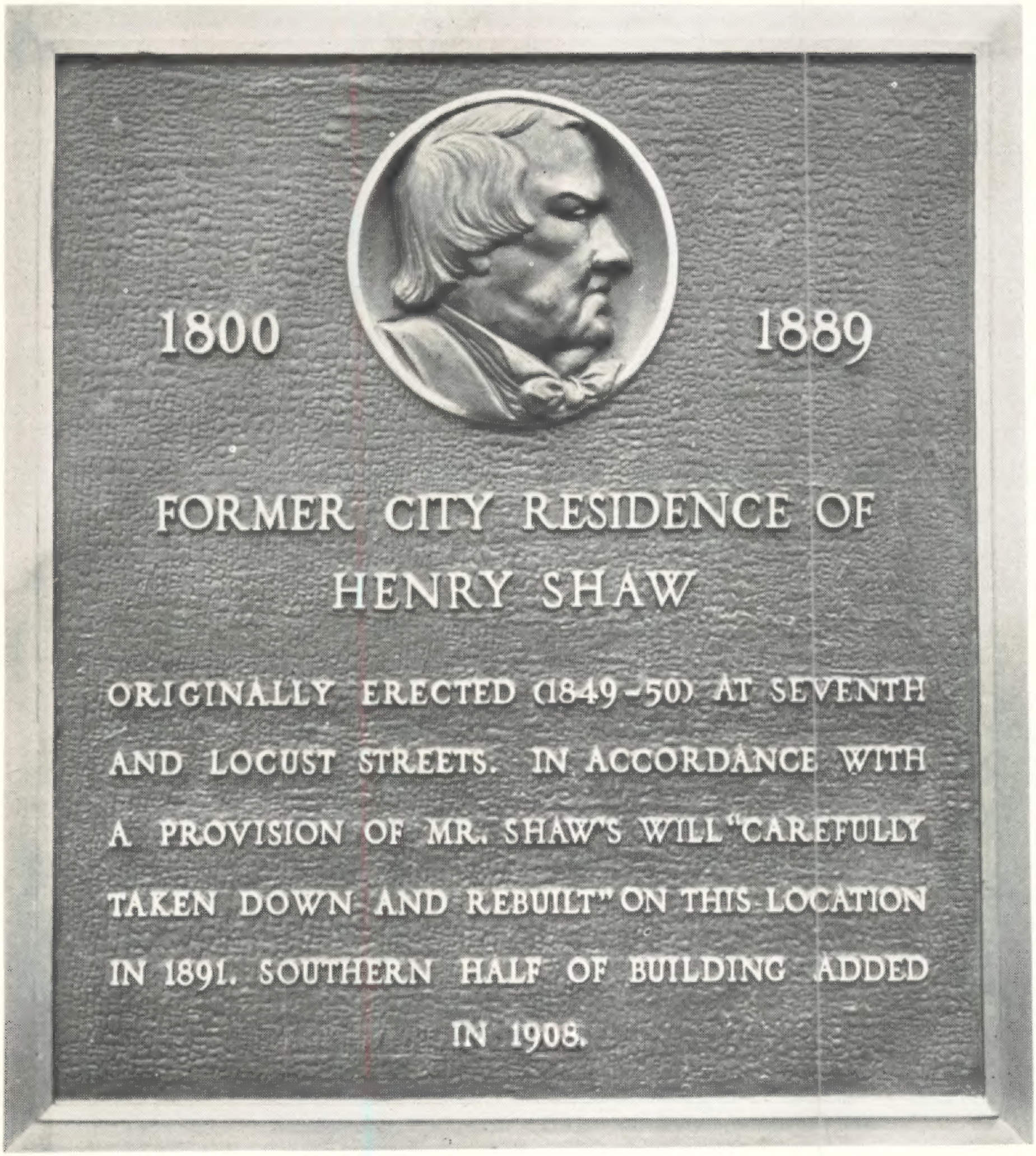
Following the rule, established several years ago, of eliminating steps wherever possible, a ramp was constructed to replace the stone steps along the south side of the succulent house. Also, a new ramp and a walk have at last provided an exit from the south end of the pergola in the Italian garden, and connect this garden with the economic garden.

The purchase of a tractor and the necessary farm tools has made it possible to eliminate the use of animals for heavy work. As a consequence, nearly twice as much labor can be accomplished in a given time and the general appearance of the Garden can be maintained in spite of the reduced force of men.

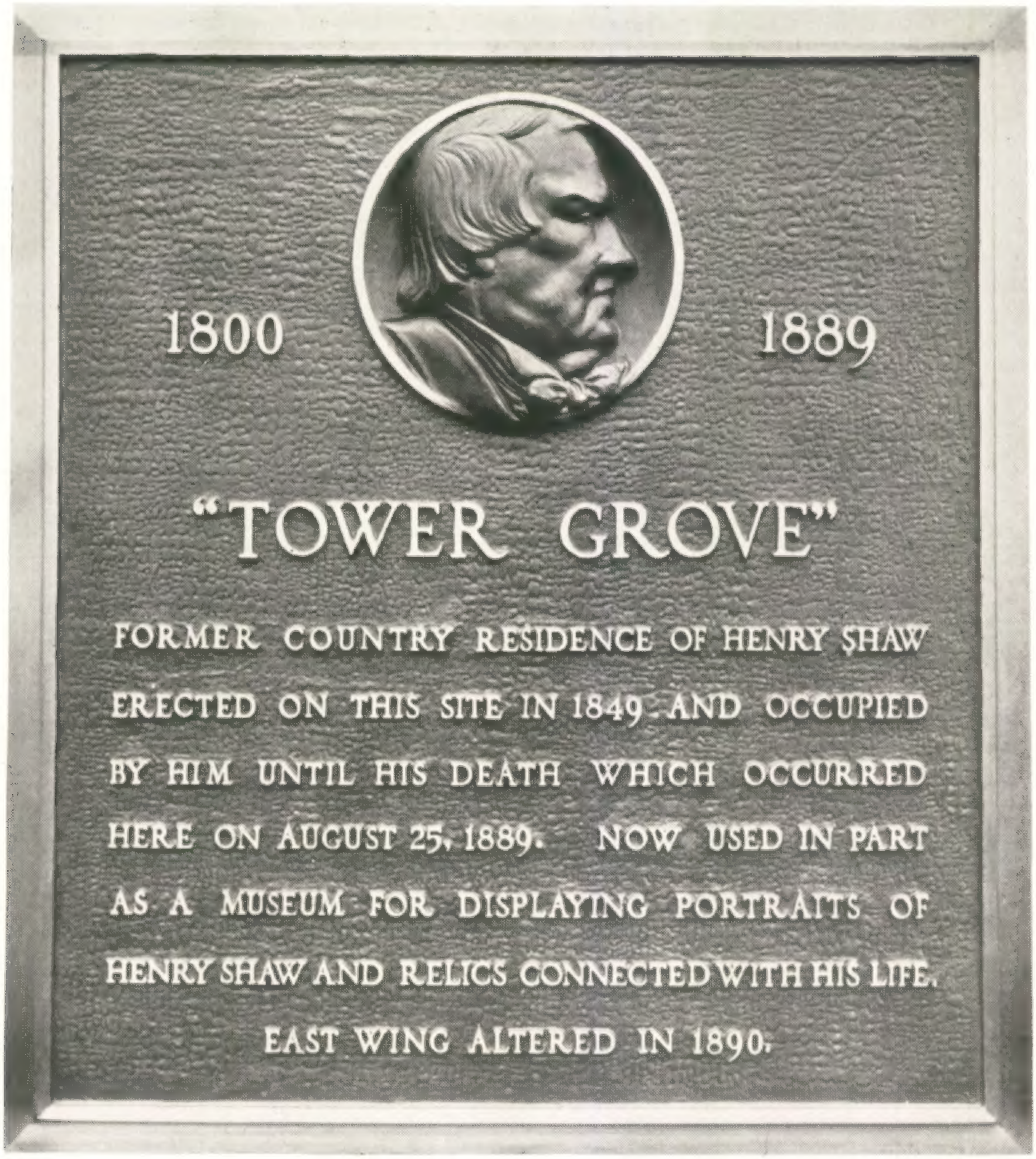
Another large item of expense was the installation of forty much-needed steel cases for the housing of the constantly expanding herbarium.

There has long been need for some kind of marker on the principal buildings which would give the visitor the information he asks for. Accordingly, an appropriate bronze tablet at the main entrance to the Garden and tablets marking the various historical structures associated with Mr. Shaw have been provided (pls. 1–4).

A department about which little is heard and yet which is fundamentally important is the heating plant. Glass houses maintained at a temperature of 60°–65° F. at night would, during zero weather, fall to freezing in from two to three hours if the heat were shut off. It is therefore necessary to maintain pumps and boilers in duplicate, so that in case of an accident or failure of



one unit the other can be used. In addition, constant vigilance on the part of the engineer in charge must be kept in order to maintain every part of the system in perfect condition, and in the summer months extensive repairs are always made. During the year, besides cleaning and scaling the three boilers, repairing grate bars, painting all pipes and parts in the boiler house, some of the work attended to was as follows: installing new blow-off valves, dismantling and resetting lengths of 10-inch pipe in tunnel, dismantling steam traps and replacing worn parts, cleaning and repairing feed water heater, replacing worn parts in boiler feed and vacuum pumps, overhauling and repairing ash conveyer, re-



moving and cleaning 315 thermostat traps, installing piping and radiators in new garage and storage sheds, besides innumerable repairs and extensions to water lines and pipes with fittings of every kind. The lowering or elimination of the concrete walls enclosing the pipe coils has improved the heat circulation, with the result that the desired temperature can now be maintained with less radiation and consequently less fuel.

Painting, with the attendant replacements and repairs, always constitutes a considerable item of annual expense. During 1935 the iron and wire fences along Shaw and Alfred Aves. and along Tower Grove Ave. from Magnolia Ave. to the administration

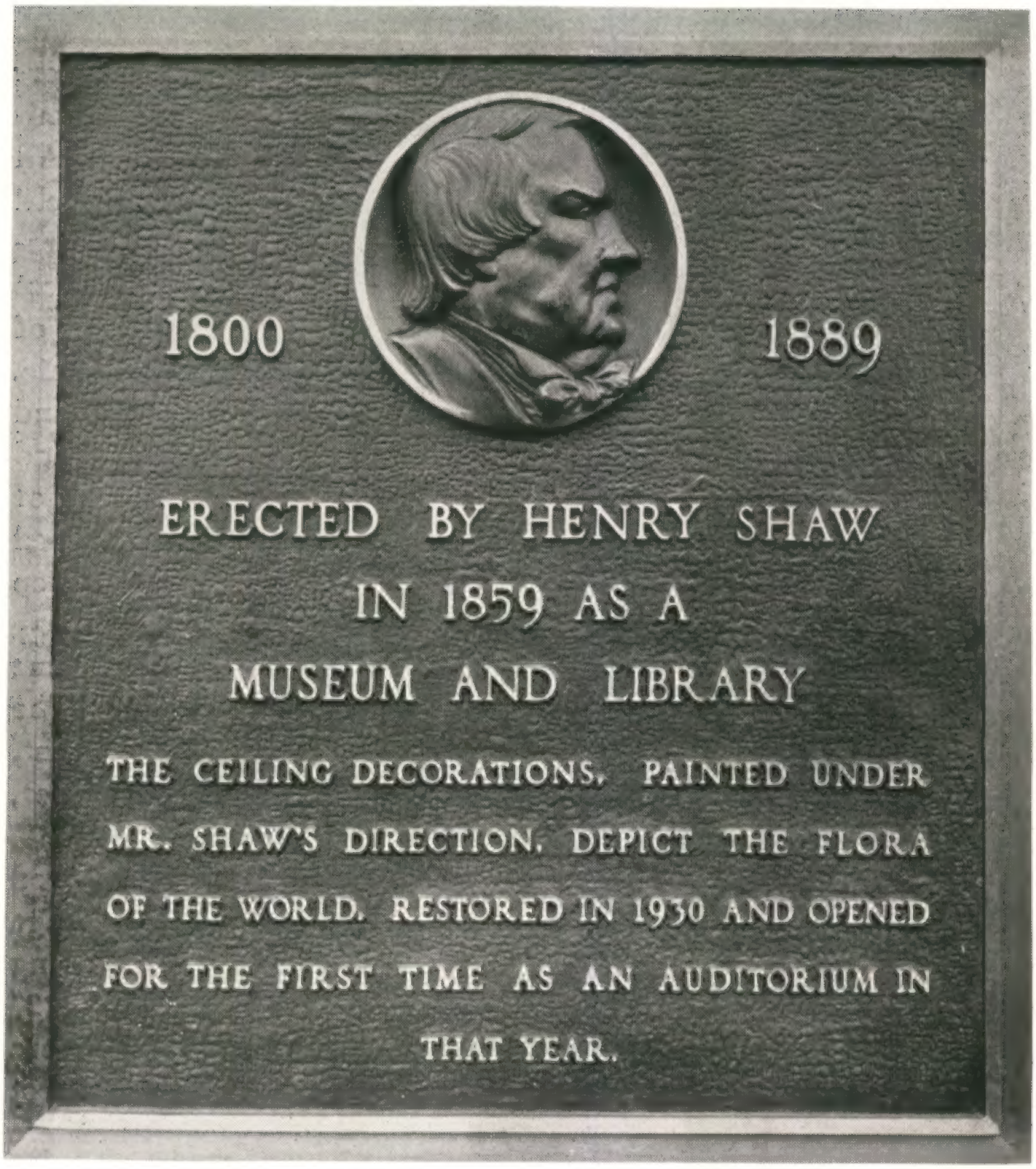
building received one coat of asphaltum. The friable sand-stone trim on that part of the administration building which was formerly Henry Shaw's city residence was given two coats of aluminum paint in an effort to prevent further disintegration. All exterior wood on the administration building, museum, and old residence, as well as the exterior of three propagating houses, received two coats of paint. The paint on both the east and west entrances to the palm house was burned off and two coats of aluminum paint applied. The interiors of the Linnean, economic, cycad, bromeliad, and plant curiosity houses were all painted, and much interior decorating was done at the superintendent's and engineer's houses. In addition, there was the usual repainting of benches, labels, etc. Over ten thousand labels were either stamped on copper, or written with ink on green celluloid and then varnished.

The need for a stable for mules no longer existing, it became possible to use the entire north service shed for a garage. The building is large enough to house the new tractor and equipment, the power sprayer, the soil shredder, trucks, and other machines, besides having room for storage of fertilizer, pots, etc.

The old corn crib, originally built by Mr. Shaw, was removed because of its unsafe condition. On account of its obvious age the timber of which it was made is of some interest. The flooring was found to be chestnut. Some of the planking measured 2″ × 22″ × 19 ft., and was in an excellent state of preservation except where it came in contact with the rafters. Here the termites and dry rot had caused some disintegration. The oak sides and the floor were held in place with hand-made cut nails, and the rafters, stringers, etc., were held with oak dowels.

MAIN CONSERVATORIES AND EXOTIC RANGES

Since the memorable hailstorm of 1927, the main conservatories have undergone great changes. Palms, ferns, cycads, economic plants, and succulents have again attained their growth, so that at no time since that date have the houses looked so well as they do at present. Particularly impressive is the palm house, where the date palms occupy a prominent place. Groups of dumb-cane and of jacobinias have greatly added to the tropic scene. A creeping pepper plant has supplanted selaginella (club moss) as a ground



cover and proves far superior, as the latter dies out during the hot summer months.

In the cycad-fern house the maidenhair ferns on the west bank are again growing luxuriantly. The tropical grape vine, with its 40-foot curtain of aerial roots, is a conspicuous feature of this house. Last year it flowered and fruited for the first time, and was able to be identified as *Cissus sicyoides* var. *Jacquini*.

In the economic house all plants have been furnished with new zinc labels on which the botanical name and other data have been inscribed. In addition, the popular names have been appended on green celluloid tags—a delight to the layman.

The regular routine of fumigating, spraying, ground cultivation, fertilizing, watering, and other necessary work which accompanies greenhouse maintenance has been carried on as faithfully as in previous years.

The new South African room now houses a collection of 200 species from that part of the world. A few bulbous plants, particularly the popular Chincherinchee, *Ornithogalum thyrsoides*, have been planted among the aloes, mesembryanthemums, and various crassulaceous plants.

The original succulent house now displays a splendid collection of cacti and other American desert plants. Much of the old ground has been carted away or mixed with leaf-mold and sand, and almost every plant has been dug up and reset in its proper place. The euphorbias are now consolidated and occupy a prominent place in the rear part of the house, as do also the small, cactus-like stapeliads. These two groups are the only South African natives to be retained in this house, all others having been removed into the new South African house. Mr. Ladislaus Cutak, in charge of succulents at the Garden, made a special trip to the Southwest during September to gather plants and seeds for the collection. There are now about 900 species of succulents at the Garden, which is almost six times the number in 1927 after the hailstorm.

The decorative features in the exotic range have been maintained on about the same lines as in previous years. The enormous stilt plants (Pandanus) began to crowd the glass tops and had to be severely pruned. All walks have been repaired and rolled.

The plant curiosities house was entirely rearranged and numerous additions have been made to the odd plants on display there.

EXPERIMENTAL HOUSES

Seeds of 1,500 or more species and varieties of ornamental plants were obtained from various botanical gardens and seed companies. Extensive plantings were made of Aster, Achillea, Aquilegia, Alyssum, Chrysanthemum, Dianthus, Doronicum, Helianthemum, Helianthus, Hemerocallis, Helenium, Linum, Lychnis, Oenothera, Penstemon, Potentilla, Silene, Solidago, Thalictrum, and Veronica, all of which are dependable in this climate and many have garden merit. A considerable number have been added to the collection of rock-garden plants, the rest being held over in

the nursery. Severe roguing is necessary, as a large proportion of the plants tested prove to be worthless from a decorative standpoint.

Practically all available species of Penstemon, Dianthus, Aster, Thalictrum, and Veronica have been tried. It is hoped that more attention can now be given to the varieties, as many of them will probably surpass the species. Additional important genera, such as Campanula, Lilium, Rosa, Saxifraga, Primula, and Sedum will be tested in 1936. Most of the important commercial varieties of geraniums are being raised to determine their values as bedding material. Some have shown definite promise in spite of adverse weather conditions, but there are still many varieties—mostly foreign—to be tried.

Instead of digging and storing the gladiolus corms as usual, the plantings were undisturbed. One section was then well mulched with leaves and another section was left uncovered in order to see what treatment was practical in this locality. Another experiment undertaken consisted in treating a number of orchids with commercial fertilizers, then potting them in various peat combinations. No beneficial results were noted after two years, and the experiment has been discontinued.

Experiments now in progress include an investigation of the effects of city rain water on plant growth, and hybridization of penstemons, pelargoniums, and begonias.

INDOOR FLORAL DISPLAYS

At the beginning of the new year preparations were intensified for the Greater St. Louis Flower and Garden Show which was held at the Arena, March 30–April 7. A shipment of rhododendrons from the East was planted in boxes and forced, and the azaleas which the Garden has maintained in pots since 1928 were held in storage for this show. The rhododendron and azalea garden covered 3200 square feet of floor space in the west "B" building at the Arena, and consisted of a shelter house and terrace which overlooked a formal garden of these plants (pl. 5). After the flower show some of the rhododendrons and azaleas were used in the spring display in the floral display house at the Garden. On May 15 hydrangeas were added.

RHODODENDRON AND AZALEA GARDEN AT THE GREATER ST. LOUIS FLOWER AND GARDEN SHOW. ARENA, APRIL, 1935

The exhibit of orchids occupied the south end of the Arena and formed the main attraction of the entire show (pls. 6, 7). Looking from a patio garden through arches one saw a panorama of the Andes Mountains in the distance. This was painted from photographs taken during the Garden's expedition to Colombia in 1923. The building was 38 feet long, 18 feet high, and 16 feet deep, with two separate display alcoves at each end, the total frontage measuring 54 feet. The center building contained both epiphytic and terrestrial orchids, the former upon trees in their natural position. An alcove at each side illustrated the formal method of showing orchids, using dark green velvet as a background. In the east alcove was the Sir Jeremiah Colman collection, shipped from England in full bloom. The thirty hybrid odontoglossums were the outstanding exhibit of the flower show. For his exhibit the Henry Shaw Gold Medal was awarded to Sir Jeremiah, a full account of which will be found in the June, 1935, BULLETIN. In the west alcove were the Garden seedlings and botanical orchids. Approximately 5,000 flowers were displayed, including the following genera: Vanda, Aerides, Cattleya, Laeliocattleya, Brassocattleya, Oncidium, Cymbidium, Dendrobium, Lockhartia, Odontoglossum, Lycaste, Brassia, Epidendrum, Phalaenopsis, Maxillaria, Catasetum, Paphiopedilum, and Phragmopedilum. The native *Cypripedium acaule* was also included to show the difference between tropical and domestic "lady-slippers."

The St. Louis Horticultural Society held its spring flower show on May 25 and 26. During the summer months a collection of fancy-leaved caladiums was maintained in the display house.

Throughout the first and second week of October the Veiled Prophet Queen's bouquet was on display. A fall flower show under the auspices of the St. Louis Horticultural Society had been planned for this month, but due to the unusually early frosts it was canceled.

At the chrysanthemum show in November, the largest collection of cascade chrysanthemums ever assembled was staged in the south end of the floral display house (pl. 8). The show was much admired, but the weather during the greater part of the month was so unfavorable that the attendance did not equal that of the previous year.

CENTRE PANEL OF GARDEN ORCHID DISPLAY AT GREATER ST. LOUIS FLOWER AND GARDEN SHOW, ARENA, APRIL, 1935

ORCHIDS FROM SIR JEREMIAH COLMAN COLLECTION, SHIPPED IN FULL FLOWER FROM ENGLAND FOR GREATER ST. LOUIS FLOWER AND GARDEN SHOW

The pink, red, and white poinsettias, "Christmas Gold" chrysanthemums, stevias, and geraniums were displayed in the December show.

OUTDOOR PLANTING

Linnean Garden.—Many of the groups of irises in the Linnean garden were divided and reset in June. The beds surrounding the lily pools were entirely replanted with irises and other perennials. In order to make these beds attractive during the first of the season sweet alyssum, verbenas, gladioli and tigridias were planted between the perennials. In the spring the latest varieties of Korean chrysanthemums and fifty new and standard early-flowering varieties were planted, and these made an excellent display in October. Again, in the fall many perennials were divided and reset, and tulips were planted.

Rose Garden.—Weekly applications of dusting sulphur, supplemented by a special rose spray, prevented the appearance of black spot in the rose garden during the past season. The bush roses did not bloom as well as in the previous year, this being the experience of every rose grower in this locality. It is practically impossible to offer an explanation for this condition, but no doubt the excessive rainfall and cloudy weather of June, followed by heat and dry weather, were contributing factors. In the fall four large beds were drained and in three beds the soil was renewed. Only five beds now remain in the main body of the rose garden in which the soil has not been changed.

As a winter treatment in former years the soil was drawn up around the base of the roses and the various ornamental grasses, mostly Miscanthus, were used to cover the beds, but these grasses were awkward to handle. Baled straw has also been tried but this is usually too short. For the past two years the annual grass, *Pennisetum Ruppelii,* has been used as a winter mulch on roses and has been found most satisfactory. Each pennisetum grass is dug with the roots attached, then spread in fan-fashion, and tucked in and around the rose plants. Keeping each grass plant intact prevents it from being blown about and also facilitates the removal of the mulch in the spring. This year 900 of these grass plants were grown in the nursery.

CHRYSANTHEMUM SHOW, 1935

With the purchase of an additional thousand standard labels last spring, it was possible to label all of the irises, peonies, roses, and perennials at one time. In previous years the rose garden could not be labeled until after the iris season.

Italian Garden.—The Italian garden was very colorful during the summer. Formerly, the bedding plants, such as coleus and acalyphas, were planted out from 2½-inch pots, but in some years the heat and drought checked their growth for many weeks. Last spring plants from three- and four-inch pots were used, and they became established much sooner and their growth was not checked. This method of planting will be repeated in subsequent years so that this garden may assume a finished appearance earlier in the summer.

Economic Garden.—The economic garden contained the usual farm and textile crops. It was formerly possible to harvest a crop of peanuts, but in the last few years the squirrels have dug them just as they were maturing. This year the squirrels did not wait for fall but ate the individual seeds before or soon after germination. Several sowings were made but only about a dozen plants survived. In order to keep the rabbits from eating all the leaves of soybeans it has become necessary to cover the seedlings with wire chicken netting. It is only natural that with the diminishing food supply in the past few years, due to drought and to the smaller area which now comprises the Garden, these rodents must vary their food habits. The crop of rice failed to mature this year on account of unfavorable growth during the summer and the heavy frost at the time when the seed was ripening. This is another crop which the sparrows and squirrels will destroy in a few days when the seed is maturing.

Iris Test Garden.—The irises in this garden were a beautiful sight in May. It would probably be better to refer to this garden as the American Iris Society display garden, instead of a test garden, as no new varieties of irises have been received recently from the society or any of its members. Even now the collection is out of date, and a visitor who wishes to see the best of the new varieties introduced in the last few years will be disappointed. The only varieties that can be shown are the standard sorts introduced before 1930.

Lawns and Nursery.—Almost a ton of iron sulphate was applied in liquid form to eradicate chickweed on the lawns, and it was found necessary to hoe this weed from some sections during April and May. Power mowing of the lawns started earlier than usual this year, March 28. A total of 9,240 square feet of sod was taken from the main garden and nursery for use as a border around the walks of the rose garden, floral display house, medicinal garden, etc., and the lawn in the main garden was replugged with stolons from the nursery. Watering of bent grass areas began on July 12 and continued for about ten weeks.

In the mausoleum the Baltic ivy was reworked and 3,500 more plants were added. A shipment of 100 *Azalea mollis* and 20 *Buxus sempervirens* from the Arboretum was also used here. The ground at the east of the administration building was dug up and replanted with ivy.

About 20 acres of red-top hay were cut, raked, and finally traded for manure. An application at the rate of 22 tons per acre—of manure was made to the nursery. Most of the nursery was plowed twice during the summer. The compost, manure, and leaf-mold piles were turned, and the oldest piles shredded into the covered bins. During the year 126 cubic yards of compost, 63 cubic yards of leaf mold, and about 5 cubic yards of manure were handled in this manner. Eleven loads of compost were hauled to the cactus house.

ATTENDANCE FOR 1935

(Not including visitors to Arboretum and Tropical Station)

	Week-days	Sundays
January	4,309	2,985
February	5,521	3,581
March	7,543	8,544
April	12,942	15,111
May	17,387	12,961
June	16,314	11,335
July	16,742	7,702
August	20,835	10,250
September	22,040	14,342
October	16,531	11,814
November	24,745	23,275
December	6,493	9,832
	171,402	131,732
		171,402
Total		303,134

THE ARBORETUM

While the Arboretum at Gray Summit cannot as yet be opened to the public, progress is being made towards the time when this may be possible. The building containing the reception and rest rooms, with keeper's lodge, and garage, is almost complete, and when the gateway and the necessary planting are finished the entrance will be unusually attractive.

Work has continued, with the limited funds available, of developing the various nurseries and plantations. During the year there have been established in permanent places 1,900 deciduous trees and shrubs, 500 coniferous trees, 475 rhododendrons, besides a quantity of miscellaneous lilies and shrubs. About 300 trees and shrubs were supplied to the city garden, and over 5,000 trees and shrubs were transplanted from seed-beds to nursery rows. Five hundred plants of *Euphorbia corollata* were collected and established in the nursery. One thousand linear feet of seed-beds and frames have been added, and approximately 2,000 cuttings of woody plants have been made. Also, 2,000 small plants of *Lilium regale* grown from seed are now being established.

The orchards were regularly pruned, sprayed, and cultivated, and are in excellent condition. Ninety-five apple trees and 130 Japanese flowering cherries were added to the collection.

Torrential rains during the summer months necessitated considerable grading and repairs to the roads. Approximately 1½ miles, 100 feet wide, were cleared through the woods for the building of future roads. Owing to a change in administration, the boys' camp was closed by the authorities on October 23. Up to that date the number of boys engaged averaged ten a day. During January and February they were employed in clearing the woods for roads, and the remainder of the time they assisted with planting and cultivating.

The farmhouse near the stables was provided with a new roof and gutters and the rooms repapered ready for occupancy. Many of the old buildings surrounding this house were wrecked, and the premises were generally cleared up.

Orchids.—Previous reports have listed the blooming of 27 different hybrids grown from seed at the Arboretum. The following have come into flower during the past year:

	DATE GERMINATED	DATE FLOWERED
Cattleya Schroederae × *Brassocattleya Fournierii*	June 1, 1928	Jan. 3, 1934
Dendrobium Thwaitesiae × *Dendrobium Thwaitesiae* var. *Veitchii*	Feb. 6, 1929	March 20, 1935
Cattleya "Princess Royal" *alba* × *Laeliocattleya* "Black Prince"	Aug. 1, 1927	July 11, 1935
Laeliocattleya Wellsiana × *Laeliocattleya* "General Maud" var. "Victory"	Dec. 12, 1928	Dec. 10, 1935

Some of these hybrids are among the finest ever grown at the Garden. Approximately 18,500 orchid flowers have been produced during the past year, and about the same number of plants have been repotted. The number of flowers was distributed as follows:

Cattleya Trianae	1,000
Cattleya Schroederae	1,000
Cattleya Mossiae	1,200
Cattleya labiata	3,200
Hybrids	1,675
Paphiopedilums	2,450
Dendrobiums	4,200
Phalaenopsis	175
Cymbidiums	500
Innumerable botanical species.	

Henry Shaw Gardenway.—On May 30, 1935, five handsome tablets were dedicated at points of special significance along the Henry Shaw Gardenway, that portion of U. S. Highway 66 which has been designated in honor of Henry Shaw. A full account of these ceremonies will be found in the June, 1935, BULLETIN. Property owners along the Gardenway have donated easement rights on each side to provide a uniform right-of-way of 200 feet. Title to this land remains with the owners, permission having been granted for improvement and maintenance of the strip by the Highway Department of the State, conforming to National Park standards. Considerable progress has been made in grading and preparing this land, and the work of collecting and growing native and other material for planting has been continued throughout the year in a special nursery set aside for this purpose in the Garden Arboretum.

HOURS OF SUNSHINE RECORDED IN 1935

As has been repeatedly pointed out in these reports, the amount of sunshine available at Gray Summit throughout the year is from 85 to 200 hours more than that recorded at the Garden in St. Louis. The important factor is that the additional sunshine available at Gray Summit is during the winter months when light is of prime importance in developing flowers under glass. During the six winter months of 1935, there were 107 more hours of sunshine at Gray Summit than at the City Garden. Without question, quite apart from the elimination of the smoky atmosphere, the additional sunlight makes it possible to bring successfully into flower many more orchids at the Arboretum greenhouses than would be possible in the city.

Month	City Garden	Arboretum
January	100	113
February	99¾	117¼
March	115	120
April	140	134¾
May	120	126½
June	215	218
July	282	279¼
August	237	210
September	254½	246
October	140	163½
November	91¾	100¾
December	84½	123½
	1,879½	1,962½
		1,879½
Excess at Arboretum		83

TROPICAL STATION, BALBOA, C. Z.

The death, in April, of Mr. A. A. Hunter, Manager of the Tropical Station, was reported in the April BULLETIN. Under his direction the Station has been enlarged and improved from year to year until it is recognized as one of the show places on the Canal Zone, and the number of visitors from the Canal Zone and the Republic of Panama, as well as from ships at dock, is very gratifying. The change in the aspect of the property since 1930 is truly remarkable. Proper labels have been affixed to the specimens, increasing considerably the interest of visitors and also the value of the collections. Mrs. Hunter has been placed in temporary charge

of the Station until some more permanent arrangement can be made, and has successfully carried on its management.

Since the completion of Madden Dam certain localities in Panama have become more accessible for exploration. Various members of the scientific staff took advantage during the past season of this new opportunity and made collections of plants of all kinds which are referred to in greater detail elsewhere in this report. The Director and the Superintendent of the Garden spent a week at the Station in March.

ANNUAL BEQUESTS

The annual flower sermon "On the wisdom and goodness of God as shown in the growth of flowers, fruits, and other products of the vegetable kingdom," provided for in the will of Henry Shaw, was preached at Christ Church Cathedral on May 12, by the Rt. Rev. Edward L. Parsons, D.D., Bishop of California.

The Trustees' Banquet Fund, inaugurated under the will of Henry Shaw, was not drawn upon during 1935.

The Gardeners' Banquet Fund was drawn upon at Christmas time for the provision of turkeys and boxes of apples for employes of the Garden.

The fund for the provision of prizes at flower shows was not used during 1935.

RESEARCH AND INSTRUCTION

Changes in the staff during the year have been the appointment of Dr. Edgar Anderson as Geneticist to the Garden and Professor in the Henry Shaw School of Botany of Washington University, and the advancement of Dr. Robert E. Woodson, Jr., Research Assistant to the Garden, from Instructor to Assistant Professor in the Henry Shaw School of Botany.

Dr. J. M. Greenman, Curator of the Herbarium and Professor in the Henry Shaw School of Botany of Washington University, in addition to curatorial duties, has directed as usual the research work of graduate students in taxonomy and has given advanced courses in morphology and taxonomy, and in plant geography. He has also continued special research in taxonomy and has advanced the preparation of manuscripts for works which have been

for some time in progress. Dr. Greenman was the official delegate of the Missouri Botanical Garden to the Sixth International Botanical Congress which was held at Amsterdam, Holland, September 2–7, 1935. He was also the official delegate of the St. Louis Academy of Science, and of the Illinois State Academy of Science. While in Europe Dr. Greenman visited the herbaria and botanical gardens of the Universities of Amsterdam, Copenhagen, Hamburg, Leiden, and Utrecht, where studies were made of type specimens and authentic material of early American collections. Important contacts were made at all these institutions.

Dr. C. W. Dodge, Mycologist to the Garden and Professor in the Henry Shaw School of Botany of Washington University, returned in February from an expedition to Panama, as is noted below. He also spent a week in July collecting lichens and fungi in Wardsboro, Somerset, and Stratton, Vermont, and the rest of the summer in studying tropical American Stictaceae. A study of the lichens so far collected in the Galapagos Islands is nearing completion, based in large part on the collections of Dr. W. R. Taylor on the G. Allan Hancock Expedition, 1934. During the autumn, Dr. Dodge has been studying the plants of the Second Byrd Antarctic Expedition, by far the most extensive collection of plants from the Antarctic continent. These were obtained through the kindness of Mr. Paul Siple, botanist of that expedition. While the collections from the Edsel Ford range in Marie Byrd Land are more extensive, there is a good representation from the mountains of Queen Maude Land, including some specimens from within 200 miles of the south pole, collected by Mr. Quin Blackburn and party.

Dr. Dodge's long-delayed work on "Medical Mycology" was published in December and necessitated much time for editorial supervision of proofreading and index. This work describes all of the fungi which have been reported pathogenic to man and other mammals and fills a long-felt want as a reference work in this field for medical men. It also contains a new classification of yeasts and related fungi based upon new concepts as to their phylogeny, also a consideration of the relations of parasitism to sexual degeneracy in the Trichophytoneae, a group of fungi causing ringworm. With Dr. Morris Moore, a former student, now

holding a John Simon Guggenheim Memorial Foundation Fellowship to South America, Dr. Dodge has completed a study of the cytology and systematic position of *Monilia inexorabilis,* a fatal disease-producing fungus in Argentina, and reported it at the Mendoza meeting of the Sociedad Argentina de Patologia Regional del Norte.

The usual courses of instruction have been given. A new course on Medical Mycology is being offered the second trimester of the academic year 1935–1936 at the Medical School. With Mr. David Goldring, research is in progress on the influence of environmental factors on variation and reproduction in the Mucorales.

Dr. Edgar Anderson, Geneticist to the Garden and Professor in the Henry Shaw School of Botany, assumed his duties on September 1. The major portion of his time has been spent upon various aspects of the species problem. Three papers are in press and others are in preparation.

Dr. E. S. Reynolds, Physiologist to the Garden and Associate Professor in the Henry School of Botany of Washington University, has continued his study of tree temperatures. A careful analysis of the several years' results is being made, and a report of these is being prepared. Besides revealing an important thermostatic action in dicotyledonous trees under high-temperature conditions which has not heretofore been reported, probable important bearings upon the question of the transfer of water through tall, woody plants are indicated. Further studies on the effects of ultra-violet radiations upon the growth and various individual physiologic processes of plants are in progress including especially possible relations to growth hormones. Studies on the yeast stimulation of fungi in cultures have shown that important growth stimulants for this class of plants are present in yeast extracts and effective in extremely minute fractions. Further investigations of the identity of the stimulating substance and its relationships to the known vitamins and the "bios" of yeast are projected. Elementary and advanced courses in plant physiology, the supervision of the investigations of graduate students, and the general supervision of the botanical work on the campus have been carried on as usual.

Dr. Robert E. Woodson, Jr., Research Assistant to the Garden

and Assistant Professor in the Henry Shaw School of Botany, has, as in previous years, spent the major portion of his research work upon the taxonomy of the Apocynaceae. Two parts of a monographic treatment of the American genera of Echitoideae have been published in the ANNALS OF THE MISSOURI BOTANICAL GARDEN in 1933 and 1935 respectively. Progress upon the third and concluding part has been made during the present year, and it will probably be ready for publication early in 1936. The completed work will fill a great need in the taxonomy of tropical American flowering plants. Minor taxonomic projects have been pursued as well, notably a revision of the species of the genus *Tradescantia* indigenous to the United States, studied in collaboration with Dr. Edgar Anderson, Geneticist to the Garden. Research upon the floral anatomy of certain genera of the families Apocynaceae, Asclepiadaceae, and Gentianaceae has been greatly facilitated through the technical aid of Dr. John Adam Moore, formerly Rufus J. Lackland Fellow of the Missouri Botanical Garden, who was employed for the academic year 1935–36 as a research assistant through financial aid granted by the Committee on Science Research Fund of Washington University. Results of these studies are in preparation for publication.

As in previous years, Dr. Woodson has spent most of his time in conducting classes in botany in the Henry Shaw School of Botany of Washington University. That the past year has been a successful one is manifest by an increased enrollment and the interest shown by the individual students. He has also supervised the research in plant morphology of Helen M. Bramsch, A.B., Washington University, who is studying the systematic anatomy of leaves of species of *Tradescantia,* and of Henry N. Andrews, Jr., B.S., Massachusetts Institute of Technology, who is engaged in an anatomical study of various fossil woods from the Cretaceous of Wyoming.

The Tropical Station at Balboa has given an effective demonstration of its value as a base for the study of the Panamanian flora. Dr. Dodge, with Dr. Julian Steyermark and Mr. Paul Allen, spent most of January in the region of Madden Lake, with headquarters at the Río Indio Hydrographic Station, and in following up each of the tributaries as far as the Quebrada Las

Palmas. Drs. Dodge and Steyermark returned in February, leaving Mr. Allen to collect in various localities in Panamá and Coclé provinces, some of the longer trips being in company with Mr. A. A. Hunter, the late Manager of the Tropical Station at Balboa, or with Dr. D. P. Curry, Assistant Chief Health Officer of the Panama Canal. Large collections were made along the Río Chepo, on Taboga Island, the famous Valle d'Anton, and in the mountains of the continental divide above Penonomé. After Mr. Hunter's death, Mr. Allen collected in Chiriquí province, returning to the Garden in early May. The expedition resulted in about 16,200 herbarium specimens and several hundred living plants, predominantly orchids. These collections are being studied by Dr. Dodge, Dr. Woodson, and several other specialists.

Dr. Woodson, in company with Professor George W. Martin of the State University of Iowa, and Mr. Russell J. Seibert, a senior in the College of Liberal Arts of Washington University, used the Tropical Station as their headquarters in June, July, and August. The party made several collecting trips into rather poorly known regions of the Republic of Panama, notably by plane to the region west of the Volcan de Chiriquí, in Chiriquí Province, and to the interesting "fossil" crater of an extinct volcano known as El Valle d'Anton, in the Province of Coclé. In these trips they were accompanied by Mr. Adrien M. Bouché, Jr., an employee of the Panama Canal, who is a very active student of the Panamanian flora. Professor Martin is a well-known student of fungi, particularly of Myxomycetes and the lower Basidiomycetes. During the months of June and July he found much to interest him, both in the grounds of the Station itself and upon the several expeditions from Balboa. The principal object of the trip was to collect as representative a collection of ferns and flowering plants as the time would permit. Some 3,000 dried specimens for herbarium use were secured. Duplicates of many of the families have been sent to prominent specialists in the United States, and numerous new species and new records added to the flora of Panama.

The location of the Tropical Station in such a favorable region for botanical exploration makes it seem logical that the Missouri Botanical Garden should take the lead in the study of the Panamanian flora. The past year, with the collections of Dodge,

Steyermark, and Allen, and of Seibert and Woodson, has demonstrated how easily the present equipment in Balboa could be put to use for the advancement of tropical American biology and the greater prestige of the Garden. In order to serve those ends, a series of papers based upon collections of Garden expeditions is being planned to be entitled "Additions to the Flora of Panama." These will be of great use to future students of tropical American botany, and the first number is already in preparation.

Dr. Gladys Baker, Dr. John Adam Moore, and Dr. F. Lyle Wynd have assisted in the research work of Dr. Dodge, Dr. Woodson, and Dr. Reynolds respectively, by means of grants from the Science Research Fund of Washington University, provided by the Rockefeller Foundation.

Graduates and Fellows.—The following appointments were made in the Henry Shaw School of Botany for the year 1935–36.

Assistants in Botany: (research assistant) John Adam Moore, Ph.D., Washington University; (half-time assistants): Fred Alexander Barkley, A.B. and M.S., University of Oklahoma (Taxonomy and Physiology); Henry N. Andrews, Jr., B.S., Massachusetts Institute of Technology (Anatomy and Taxonomy); Mary Maxine Larisey, A.B. and M.S., Washington University (Taxonomy and Anatomy).

Washington University Fellowship: Louis Otho Williams, A.B. and M.S., University of Wyoming (Taxonomy and Anatomy).

Jessie R. Barr Fellowship, Washington University: Helen Marie Bramsch, A.B., Washington University (Anatomy and Zoology); Ruth E. Peck, A.B., Grinnell College.

Washington University Van Blarcom Scholarship: Stanley H. Hagen, B.S., University of Oklahoma.

Special Research Fellowship, American Creosoting Company: Hereford Garland, B.S., M.S., University of California (Physiology).

Independent Students: Gordon William Davis, A.B., Knox College (Physiology); Noel Moore Ferguson, B.S., St. Louis College of Pharmacy, A.B., Washington University (Physiology); George Bippus Happ, B.S., M.S., Cornell University (Taxonomy); David Floyd Waugh, A.B., Washington University.

Degrees.—The following students in the Shaw School of Botany received advanced degrees at the Washington University commencement: Doctors of Philosophy—Gladys Elizabeth Baker (Mycology and Taxonomy), Mary Elizabeth Pinkerton (Mycology and Morphology); Master of Science—Noel Moore Ferguson (Physiology).

Apprenticeships.—Apprentices now enrolled under the three-year arrangement are Karl E. Busch, Francis C. Harris, and Arthur B. Hoffman. Paul Allen, Wilbert Quest, and Littleton Rubinstein graduated during the year and received the certificate for satisfactory completion of the work.

The lecture and demonstration course in gardening for amateurs, and a second course, of a more advanced character, were given during 1935, with as full a registration as could be taken care of. A tree-finder course for Girl Scouts was also given by Dr. Fairburn.

Published Articles.—

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Anderson, Edgar. Brightening up the Rose Garden in Late Summer. Mo. Bot. Gard. Bull. **23:** 125–127. 1935.

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Anderson, Edgar. Sporting of the Chrysanthemum. Mo. Bot. Gard. Bull. **23:** 161–163. 1935.

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Barkley, Fred A. (with Barkley, W. W.). Negro Herb Doctoring. Mo. Bot. Gard. Bull. **23:** 143–149. 1935.

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Beilmann, August P. Common Native Trees of Missouri. I. The Soft Maple (*Acer saccharinum* L.). Mo. Bot. Gard. Bull. **23:** 80–82. 1935.

Beilmann, August P. The Feeding of Shade Trees. The Shade Tree **8**[4]. April, 1935.

Beilmann, August P. Moisture and Temperature Relations in Trees. Mo. Bot. Gard. Bull. **23:** 51–54. 1935.

Beilmann, August P. New or Noteworthy Plants for St. Louis. VII. Buckthorns. Mo. Bot. Gard. Bull. **23:** 37–38. 1935.

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Dodge, Carroll W. (with Zeller, S. M.). New Species of Hydnangiaceae. Ann. Mo. Bot. Gard. **22:** 365–373. 1935.

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Greenman, J. M. New or Noteworthy Plants for St. Louis. IX. *Senecio confusus,* A Novel House Plant. Mo. Bot. Gard. Bull. **23:** 91–92. 1935.

Jensen, Lars P. The Propagation of the White Redbud. Mo. Bot. Gard. Bull. **23:** 38–39. 1935.

Kohl, Paul A. An Old Yucca Blooms Again. Mo. Bot. Gard. Bull. **23:** 65–67. 1935.

Kohl, Paul A. *Teucrium Chamaedrys* (Germander). Mo. Bot. Gard. Bull. **23:** 127–130. 1935.

Moore, George T. Gardening as a Hobby. Mo. Bot. Gard. Bull. **23:** 49–50. 1935.

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Pring, George H. Orchids that Grow Downwards. Mo. Bot. Gard. Bull. **23:** 92–93. 1935.

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Scientific and Popular Lectures.—

Mr. Paul Allen, Garden Apprentice in the School for Gardening: May 24, Current Events Class of the Kirkwood High School, May 31, radio talk over Station KSD, and June 10, Webster Groves Nature Study Society, "Plant Exploration in Panama."

Dr. Edgar Anderson, Geneticist to the Garden: October 30, Washington University Chapter of Phi Sigma, "The Botanical Institutions of the Balkans"; November 18, Kirkwood Garden Club, "Plant Hunting in the Balkans"; December 10, joint meeting of the Association of Childhood Education and the St. Louis

Nature Study Society, "Trees in Winter"; January 1, 1936, Botanical Society of America, "The Evolutionary Patterns of the Genus *Iris*."

Mr. A. P. Beilmann, Arboriculturist to the Garden: March 14, Biology Club of Webster College, "Native Tree Flowers"; August 28, National Shade Tree Conference, Philadelphia, "The Use of Instruments in Tree Diagnosis."

Mr. Ladislaus Cutak, in charge of Succulents at the Garden: April 16, Topeka Horticultural Society, at Topeka, Kansas, "Succulents (including Cacti) and Water-lilies"; May 16, South Side Lions Club, at Bevo Mill, "Interesting Plants of the Desert"; December 12, Velata Public Speaking Society, at the Barr Branch Library, "Vagabonding in the Southwest."

Dr. C. W. Dodge, Mycologist to the Garden: February 13, Luncheon Club at Christ's Church Cathedral, "Botanical Research and Exploration in Panama"; March 13, Academy of Science of St. Louis, "Botanical Exploration in the Vicinity of Madden Lake, Canal Zone"; March 14, Boy Scouts at St. Mary Magdalene Church, "Camping in the Jungles."

Dr. David C. Fairburn, Research Assistant to the Garden, October 8, St. Louis Section of the Council of Jewish Women, "Rock Gardens."

Dr. J. M. Greenman, Curator of the Herbarium: December 27, 1934, Botanical Society of America, Symposium at Pittsburgh, "Systematic Botany in the American Schools of Graduate Study"; May 3, annual meeting Illinois State Academy of Science, "The Genus Senecio in Illinois."

Mr. L. P. Jensen, Manager of the Garden Arboretum: January 7, at Gray Summit, "The Use of Native Material for Ornamental Planting"; March 5, Franklin County Planning Board, at the courthouse, Union, Mo., "The Importance of Regional Planting"; April 20, citizens of Boles Township, Franklin County, Mo., in behalf of Franklin County Regional Plan Association, "Soil Erosion"; April 27, St. Louis Naturalists' Club, "Twenty-five Years' Progress in Regional Planning"; April 30, at a joint meeting of the Henry Shaw Gardenway Association and U. S. 66 Highway Association, at Sylvan Beach, "Roadside Improvement"; May 21, Southwest Missouri Flower and Garden Show, Springfield, Mo., "Ornamental Planting."

Mr. Paul A. Kohl, Floriculturist to the Garden: March 1, St. Louis Horticultural Society, "From Seed to Flower"; April 15, Eastern Star of Kirkwood, Mo., "Roses."

Dr. George T. Moore, Director of the Garden: April 4, at the semi-annual meeting of the Federated Garden Clubs of Missouri, at Kirkwood, "Mr. Shaw and His Garden"; April 12, students at Girard College, Philadelphia, "Some Inside Facts About Plants"; May 10, Board of Directors of the East St. Louis Chamber of Commerce, "Illinois' Responsibility for St. Louis Smoke"; May 14, at the graduating exercises of the St. Louis City Hospital Training School for Nurses, Lafayette Park Methodist Church; May 27, Garden Club of Columbia, Mo., "Henry Shaw and His Garden"; August 20, Garden Club of Dublin, N. H., Moving-picture films of plant life; December 5, Engineers' Club of St. Louis, "Some Inside Facts on Plants"; December 31, Botanical Society of America, "The Botanist as a Creator."

Mr. George H. Pring, Superintendent of the Garden: February 5, Flynn Park School Parent-Teachers' Association, "City Gardens"; April 5, at meeting of the Federated Garden Clubs of Missouri, at the Congress Hotel, conducted Question Box; April 11, Webster Groves Parent-Teachers' Association, "Annuals and Perennials"; May 29, U. S. Veterans' Hospital, No. 92, under auspices of the Société des 40 Hommes et 8 Chevaux, "Orchid Exploration in Central and South America"; July 31, Rotary Club of Alton, Ill., "Orchid Hunting in Central and South America"; September 13, Webster Groves Home Garden Club, "Evergreens"; October 5, St. Louis Association of Gardeners, at the John Burroughs School, "The Association Between Insects and Plants"; November 19, Signal Hill Garden Club, East St. Louis, Ill., "Bulbs"; December 31, Nature Study Section of The American Association for the Advancement of Science, "The Garden as an Educational Institution."

Dr. Ernest S. Reynolds, Physiologist to the Garden: October 25, at a divisional meeting of the American Association of University Professors—Missouri chapters, in conjunction with the meetings of the Missouri Academy of Science, Kansas City, "How Institutions of Higher Education May Encourage Amateur Scholarly Accomplishment"; January 2, Botanical Society of America,

"Tree Temperatures and Thermostasy," and "Thermostasy and Water Ascent in Trees."

Dr. Hermann von Schrenk, Pathologist to the Garden: January 22, at New York, Northeastern Lumber Dealers' Association, "Termites," American Wood Preservers' Association, "Decay and Marine Borer Resistance of Creosoted Piles and Timbers in Tidewater"; April 27, banquet of the Triangle Club, Chicago, "The Experiences of a Timber Engineer"; May 14, Engineering School of Washington University, "Experiences of a Timber Engineer"; November 27, St. Louis Academy of Science, "Termites"; November 29, Missouri Historical Society, "Trees as Historians"; December 31, Botanical Society of America, "Decay of Wood in Treated and Untreated Timbers."

HERBARIUM

Constructive progress has been the outstanding feature of the herbarium activities during the past year. Additional new steel cases have been installed which have made it possible to expand overcrowded portions of the collections. New fixtures and lights have been added, and other improvements made which greatly facilitate routine work as well as the ready reference to specimens and a critical study of them. A relatively large amount of new and scientifically important material has been acquired—somewhat in excess of that obtained in 1934.

Some of the more outstanding individual accessions obtained are the following: P. Allen, 470 plants of Switzerland and the Island of Corsica; P. Allen and A. A. Hunter, upwards of 5,000 plants of Panama; Edgar Anderson, 68 miscellaneous herbarium specimens, fruit, and seeds of *Iris;* Bernice P. Bishop Museum, Honolulu, 68 specimens of fungi of southeastern Polynesia; Berlin Botanic Garden and Museum, 237 plants of Ecuador; Botanical Museum, University of Helsingfors, 300 plants of Finland; Mrs. H. P. Bracelin, 556 plants, mostly from Brazil, collected by Mrs. Ynes Mexia; Brooklyn Botanic Garden, 302 plants of eastern United States and Canada; B. F. Bush, 860 plants of Missouri, Arkansas, and Kansas; Ralph W. Chaney, about 200 plants of Mexico; Ora M. Clark, 500 plants of Mexico; Ira W. Clokey, 175 plants of California; Mrs. Rose E. Collom, 118 plants of Arizona; Cornell Uni-

versity, 208 plants of New York and New Hampshire; L. Cutak, 195 plants mostly from New Mexico; Otto Degener, 275 plants of Hawaii; Division of Plant Industry, Botanical Section, Pretoria, 130 plants of South Africa; C. W. Dodge, 8,847 (estimated) plants of Panama, collected by C. W. Dodge, J. A. Steyermark, and P. Allen; J. A. Drushel, 135 plants mostly from New Jersey and New York; C. F. E. Erichsen, 200 lichens of Germany; Farlow Herbarium, 100 fungi; A. Faure, 500 plants of northern Africa; Geo. L. Fisher, 277 plants of southern Mexico; H. S. Gentry, 297 plants of northwestern Mexico; H. A. Gleason, 1,221 plants of Brazil; Mrs. Susie Goehring, 1,056 plants from the herbarium of the late Dr. G. H. Goehring; Gray Herbarium of Harvard University, 222 plants of eastern United States, Scandinavia, etc.; G. Herter, 261 plants of Uruguay; H. H. Hume, 61 plants of Florida; E. P. Killip, 624 plants of Peru, collected by G. Klug; Lingnan University, 913 plants of China; Maude Lodewyks, 374 plants of Missouri and Arkansas; C. L. Lundell, 514 plants of the Yucatan Peninsula; Bassett Maguire, 349 plants of Utah; W. L. McCart, 65 plants of Texas; Mittelasiatische Staats-Universität, Taschkent, 75 plants of Asia; C. E. Moore, 162 plants of Tennessee and Iowa; J. L. Morrison, 202 plants of Nebraska; Naturhistoriska Museet, Stockholm, 331 plants of Brazil; New York Botanical Garden, 794 herbarium specimens and photographs of types; M. P. Porsild, 176 plants of Greenland; R. J. Seibert, 71 plants of Panama; B. Shimek, 57 plants of Iowa; J. A. Steyermark, 2,293 plants of Missouri; United States National Museum, 50 plants mostly from South America; University of California, 435 plants of California; University of Iowa, by G. W. Martin, 33 fungi of Iowa; University of Michigan, 284 plants of Mexico and Central America; University of Minnesota, 600 plants of Utah, collected by the late Dr. J. Arthur Harris; University of Missouri, 158 plants of Missouri, etc.; University of Montana, 100 plants of Montana; University of Oklahoma, 368 plants of Oklahoma and Texas; University of Wisconsin, 61 plants of Wisconsin; Fr. Verdoorn, 100 hepatics and mosses; Webster Groves Nature Study Society, 173 plants of Kansas, Colorado, and New Mexico; Th. Oswald Weigel, 45 fungi; L. O. Williams, 840 plants of western United States; and T. G.

Yunker, 385 plants of British Honduras. Many smaller, nevertheless important, collections have been received and added to the general herbarium.

This enumeration, on analysis, shows that the greatest increase to the Garden's representation of the world's flora is from the United States, Mexico and Central America, South America, Europe, Asia, and the West Indies. The order of increase to the representation of regional floras within the United States has been as follows: the central states, Rocky Mountain states, eastern states, Pacific coast states, and finally the states of the Great Basin.

Mounting and Insertion of Specimens.—The mounting and insertion of specimens has continued uninterruptedly throughout the year. Eighteen thousand, seven hundred and fifty-one (18,751) specimens have been mounted and incorporated. Following the very satisfactory practice of recent years, all new material has been twice fumigated with carbon bisulphide before distributing it into the general herbarium.

The work of distribution and reorganization of specimens became much handicapped on account of extreme congestion in herbarium cases. This difficulty was removed by the installation in September of additional new steel cases. Since that time the greater part of the collection on the second and third floors has been shifted; and thereby the excessive congestion has been relieved, and sufficient space remains for about three years of normal growth.

Exchanges.—A careful record, as in previous years, has been kept of all exchanges of herbarium material. During the past year, 5,847 specimens have been received, and 1,082 duplicate specimens have been sent to correspondents with whom exchanges are maintained. A much larger distribution of duplicates is contemplated for the coming year.

Field Work.—A considerable amount of field work has been carried on during the year by members of the staff and by students; and much valuable material has been obtained. Especially noteworthy in this connection is the collection made in Panama by Dr. C. W. Dodge, Dr. J. A. Steyermark, Mr. Paul Allen, and Mr.

A. A. Hunter. A complete series of these plants will form eventually an important addition to the general herbarium.

Use of the Herbarium.—It is again gratifying to record the extended use of the herbarium. Local botanists and visiting botanists from all parts of the United States and from foreign countries have consulted the herbarium coincident with their visits to the Garden. It is a pleasure also to record the increased use of the herbarium through loans of material to institutions for benefit of those engaged in taxonomic research. Such interherbarium loans have made it possible, here as elsewhere, to undertake a critical study of many groups of plants which otherwise would have been impracticable.

Statistical Summary (for the year ending December 31, 1935):

Number of specimens acquired on new accessions:

By purchase	13,855
By gift	2,941
By exchange	5,847
By transfer	39
By field work	15,100
Total	37,782

Number of specimens mounted and incorporated	18,751
Number of specimens discarded	15
Number of specimens in unorganized herbarium	120,356
Number of specimens in organized herbarium	1,083,307

LIBRARY AND PUBLICATIONS

Nothing outstanding can be reported in the library for the year, but the fact that it was able to maintain its former standards in spite of existing conditions is worthy of comment. The number of accessions, which has been almost uniform for the last five years, showed a slight increase over last year. This may be due partly to the fact that the Garden publications as a basis of exchange are becoming more extensive and valuable. One good happening during 1935 was the price reduction on all German periodicals. Two years ago one German publisher, whose charges had become exorbitant, was forced to reduce his prices, and last year a 25 per cent reduction on all German periodicals took place. Fortunately, the Garden had been able to keep up its file of serials without in-

terruption, which many institutions have been unable to do in recent years. That the completeness of this library is recognized may account for the fact that a greater number of requests for loans have been received during 1935 from out-of-town libraries—an increase of 30 per cent over last year.

Not only has there been a cry in the library for book space but also for space for cards. The number of books and pamphlets has almost doubled since twenty years ago, and the card filing-case, which was purchased at that time, had become so congested that it was not able to contain another year's addition. In 1935 an exact duplicate of the old filing-case was purchased, which doubles the card capacity and should be adequate for a great many years.

The smoke and the dry atmosphere are extremely destructive to leather-bound books, and their renovation is necessary more frequently in St. Louis than in some other localities. During 1933 and 1934 the books in the pre-Linnean and Linnean sections, which are devoted to old herbals and early botanical writings, were inventoried, cleaned, and oiled, and in 1935 the work was extended to the books in the folio room. Until last year two itinerant bookbinders had spent several weeks at the Garden each year in this kind of work, but in 1935 two library assistants spent the greater part of their time for six weeks in getting into condition the books in this room. However, the folios doubtless represent the most valuable collection in the library, and their upkeep cannot be neglected.

Use of the Library.—In addition to the staff and students in the Shaw School of Botany, the following botanists have made use of the library during the year: Dr. Constantin J. Alexopoulos, Instructor in Botany, University of Illinois, Urbana; Dr. Lawrence M. Ames, of the Division of Plant Disease Eradication and Control, Barberry Eradication, Arnold Arboretum, Jamaica Plain, Mass.; Prof. Ernest B. Babcock, Professor of Genetics, University of California, Berkeley; Dr. Ralph W. Chaney, Research Associate, Carnegie Institution of Washington; Mr. Jasper A. Clark, Head Biology Department, Hannibal-La Grange College, Hannibal, Mo.; Dr. A. B. Conner, Director Texas Agricultural Experiment Station, College Station; Mrs. Everett F. Davis (Dr. Fanny Fern Smith), Teacher of General Science, St. Anne's

School, Charlottesville, Virginia; Dr. Francis Drouet, In Charge of Herbarium, University of Missouri, Columbia; Dr. Ethel T. Eltinge, Assistant Professor of Botany, Mt. Holyoke College, South Hadley; Dr. W. H. Emig, Professor of Botany, University of Pittsburgh; Prof. A. T. Erwin, Associate Professor of Horticulture, Iowa State College, Ames; Dr. Samuel M. Feinberg, of Chicago; Dr. Harry J. Fuller, Associate in Botany, University of Illinois, Urbana; Dr. George J. Goodman, Instructor in Botany, University of Oklahoma, Norman; Dr. C. L. Hitchcock, Assistant Professor of Botany, University of Montana, Missoula; Mr. Anton Hogstad, of Merck & Co., New York; Mr. A. C. Hottes, Associate Editor *Better Homes and Gardens,* Des Moines; Dr. David D. Keck, Assistant in Experimental Taxonomy, Carnegie Institution of Washington Laboratory, Stanford University, California; Dr. J. Horace McFarland, president emeritus American Rose Society, and horticultural publisher, Harrisburg, Pennsylvania; Mr. L. G. McLean, of the U. S. Erosion Plant Studies, Stillwater, Oklahoma; Dr. Paul C. Mangelsdorf, Agronomist, Texas Agricultural Experiment Station, College Station; Dr. D. M. Moore, Professor of Botany, University of Arkansas, Fayetteville; Dr. E. J. Murphy, of New York University; Mr. H. C. Oberholser, Senior Biologist, Bureau Biological Survey, United States Department of Agriculture, Washington, D. C.; Dr. W. T. Penfound, Assistant Professor of Botany, Tulane University, New Orleans, Louisiana; Dr. W. O. Richtmann, Associate Professor of Pharmacy, University of Wisconsin, Madison; Dr. H. W. Rickett, Associate Professor of Botany, University of Missouri, Columbia; Mr. Donald P. Rogers, Graduate Student and Research Assistant in Botany, University of Iowa, Iowa City; Dr. Harold St. John, Professor of Botany, University of Hawaii, Honolulu; Prof. Carl Skottsberg, Prefect, Botanical Garden, Göteborg, Sweden; Dr. Ward M. Sharp, Assistant Biologist, Division of Migratory Water Fowl, Bureau of Biological Survey, Valentine, Nebraska; Dr. E. R. Spencer, Professor of Botany, McKendree College, Lebanon, Ill.; Dr. Robert Stratton, Assistant Professor of Botany and Plant Pathology, Oklahoma Agricultural and Mechanical College, Stillwater; Dr. R. A. Studhalter, Professor of Biology, Texas Technological College, Lubbock, Texas; Mr. R. S. Sturtevant, Editor

American Iris Society Bulletin; Miss Bonnie C. Templeton, of the Los Angeles Museum, Los Angeles, California; Mr. Edward C. Vick, Horticultural Editor, *New York American, Boston Advertiser,* and *Pittsburgh Sun-Telegraph;* Prof. E. C. Volz, Professor of Horticulture, Iowa State College, Ames; Dr. Ralph Voris, Head Department Biology, Southwest Missouri State Teachers' College, Springfield, Mo.; Dr. C. O. Walton, President Texas Agricultural and Mechanical College, College Station; Dr. Robert W. Webb, Senior Cotton Technologist, Bureau Agricultural Economics, U. S. Department of Agriculture, Washington, D. C.; Dr. Ira L. Wiggins, Assistant Professor of Botany, and Curator of Herbarium, Stanford University, California.

A party of about 60 members of the science classes from the Eastern Illinois State Teachers' College, Charleston, Illinois, visited the Garden library in February; and the students and instructors in the University of Illinois Library School, on its annual inspection trip to libraries, printing and engraving establishments, were visitors in April.

Out-of-town botanists from 28 institutions borrowed 130 books on the inter-library loan plan during the year.

New Accessions.—The following are some of the important library accessions during the year:

Akademie d. Wissenschaften in Wien, math.-naturw. Kl., Denkschriften Vol. 83 (1907); Arber, The Gramineae; Arnaud, Les Asterinées; Bory de Saint Vincent, Voyage dans les quatres principales îles des mers d'Afrique; Bower, Primitive land plants (also known as the Archegoniatae); Bretschneider, History of European botanical discoveries in China. 2 vols; Burnat, Flore des Alpes Maritimes, vol. 7; Canadian journal of research (new subscription); Colla, Plantae rariores in regionibus Chilensibus a clarissimo Bertero nuper detectae, 1834–36; Encyclopédie Mycologique, vol. 7; Engler, Das Pflanzenreich. IV. 32, liefs. 2, 3, 4; Engler & Prantl, Die Natürlichen Pflanzenfamilien, Heft 16b; Frey-Wyssling, Die Stoffausscheidung der höheren Pflanzen (Monogr. Gesamtgebiet d. Physiologie d. Pflanzen u. d. Tiere **32**); Fries, Opera et dissertationes, 1822–1854 (7 pamphlets); Fritsch, The structure and reproduction of the algae, vol. 1; Girod-Chantrans. Recherches chimiques et microscopiques sur les Con-

ferves, Bisses, Tremelles; Grove, British stem- and leaf-fungi (Coelomycetes), vol. 1; Grove, Supplement to Elwes' Monograph of Lilium, pt. 2; Guggenheim, Die biogenen Amine (Monogr. a. d. Gesamtgebiet d. Physiologie d. Pflanzen u. d. Tiere **3**); Gurwitsch, Die mitogenetische Strahlung (Monogr. a. d. Gesamtgebiet d. Physiologie d. Pflanzen u. d. Tiere **25**); Hooker, J. D., The cryptogamic botany of the Antarctic voyage of H. M. Discovery Ships Erebus and Terror, 1845; Jacobsen, Die Sukkulenten; Jahandiez & R. Maire, Catalogue des plantes du Maroc; Javorka & Csapody, A Magyar Flora Képekben; Komarov, Fl. U. R. S. S., vols. 2 and 3; Konrad & Maublanc, Icones selectae fungorum, fasc. IX; Krok, Bibliotheca botanica Suecana; Lemée, Dictionnaire descriptif et synonymique des plantes phanerogames, vol. 6; Macbride & Martin, The Myxomycetes; Marie-Victorin, Flora Laurentienne; Munz, A Manual of Southern California botany; Niklas, Literatursammlung a. d. Gesamtgebiet d. Agrikulturchemie. Band III. Pflanzen-nährung; Ostenfeld & Gröntved, The flora of Iceland and the Faeroes; Pareto, The mind and society, 4 volumes; Pearson & Brown, The commercial timbers of India, vols. 1, 2; Phillips, South African grasses; with notes on their structure, distribution, cultivation, etc.; Rabenhorst, Kryptogamen-Flora, IX Band, V & VI Lief.; Rockley, Wild Flowers of the Great Dominion of the British Empire; Stern, Pflanzen-thermodynamik (Monogr. Gesamtgebiet d. Physiologie d. Pflanzen u. d. Tiere **30**); Tilden, The algae and their life relations; Van Laren, Succulents other than Cacti (2nd ed.); Vajda, Flora Phytographica Hungariae, vol. 2, pts. 11–13; Van Laren, Cactus; Ungerer, Die Regulationen der Pflanzen (Monogr. a.d. Gesamtgebiet d. Physiologie d. Pflanzen u. d. Tiere **10**); Velenovsky, Monographia Discomyceten Bohemiae, pars 1, 2; Verdoorn, Chronica Botanica, vol. 1; Vickers, Phycologia Barbadensis. partie I & II; Wettstein, Handbuch der systematischen Botanik, 4th ed., vol. 2; Zechmeister, Carotinoide. (Monogr. a. d. Gesamtgebiet d. Physiologie d. Pflanzen u. d. Tiere **31**).

Garden Publications.—A great part of the time of the library staff has been taken up with editing the two journals—the ANNALS OF THE MISSOURI BOTANICAL GARDEN and the MISSOURI BOTANI-

CAL GARDEN BULLETIN. Volume XXII of the ANNALS, which was completed during the year, consists of 847 pages and 21 plates. In addition to the results of the research in the Shaw School of Botany, this volume contains a 384-page paper by Palmer and Steyermark, "Annotated Catalogue of the Flowering Plants of Missouri." On account of the anticipated demand for this work by those interested in the local flora, a limited number of extra copies were ordered, and a number of copies have already been sold. The monthly BULLETIN (Volume XXIII) was also completed during the year and comprises 187 pages and 28 plates. In April a new water-lily catalogue was issued, and in July the bulletin containing the Biography of Henry Shaw was again reprinted as a pamphlet to be sold to Garden visitors.

Both BULLETIN and ANNALS (with the exception of the "Catalogue of Missouri Plants") are sent in exchange for other publications. Seven new institutions were added to the ANNALS list during the year—from Belgium, China, Japan, Poland, Roumania, and South Africa. There are now 442 foreign and 126 domestic institutions exchanging their publications for the ANNALS, and 40 foreign and 58 domestic institutions exchanging with the BULLETIN. In August about 1,200 reprints from the ANNALS were sent to 250 botanists in this country and abroad in exchange for their publications. The cash receipts during the year from sale of ANNALS, BULLETIN, and other Garden publications was $1,480.88.

Statistical Information.—There have been donated to the library or received in exchange during the year 576 books valued at $1,369.75, 1,527 pamphlets valued at $252.93, and three manuscripts valued at $15.60. Three hundred and twenty-seven books were bought at a cost of $2,785.83, and 70 pamphlets at a cost of $96.96. The library now contains 50,354 books and 76,305 pamphlets. There are 335 manuscripts valued at $1,637.40, and 1,022,227 index cards valued at $12,502.01. A total of 7,775 cards were added during the year, of which 1,235 were written by Garden employes, and 6,540 were purchased at a cost of $136.83. One hundred and nine books were bound.

GEORGE T. MOORE,
Director.

STATISTICAL INFORMATION FOR DECEMBER, 1935

GARDEN ATTENDANCE:

Total number of visitors	16,325

LIBRARY ACCESSIONS:

Total number of books and pamphlets bought	17
Total number of books and pamphlets donated	512

PLANT ACCESSIONS:

Total number of plants and seed packets donated	164

HERBARIUM ACCESSIONS:

By Purchase

Fisher, George L.—Plants of Mexico	77
Hermann, F. J.—Plants of Utah and Colorado	820
Lingnan University—Plants of China	719
Schipp, W. A.—Plants of British Honduras	71
Thompson, J. William—Plants of Washington	1,200

By Gift—

Anderson, E.—*Dirca palustris* L. from Missouri	1
Baker, Miss G. E.—*Wolffia* sp. from Iowa	1
Chase, Miss Rhoda—*Cystopteris fragilis* (L.) Bernh. from New York	1
Drushel, J. A.—Plants of New York, New Jersey, and Vermont	87
Hanes, Clarence—Senecios from Michigan	4
Hermann, F. J.—Plants of Utah and Colorado	63
Kiener, Walter—Photograph of *Primula Parryi* Gray	1
Kurz, Herman—*Baptisia simplicifolia* Croom from Florida	3
Penn, Ray E.—*Cenchrus* sp.	1
Sharp, Ward M.—*Selaginella rupestris* (L.) Spring from Nebraska	1
Steffen, H.—Senecios of Alaska and Nova Zembla	5
Studhalter, R. A.—*Riella americana* from Texas	3

By Exchange—

California Academy of Sciences—Plants of California, etc.	338
Demaree, Delzie—Plants of Ohio	181

By Transfer—

Moore, G. T.—*Oncidium* sp. from horticulture	1
Total	3,578

SOME FACTS ABOUT THE GARDEN

The Missouri Botanical Garden was opened to the public by Mr. Henry Shaw about 1860. From that date to the death of Mr. Shaw, in 1889, the Garden was maintained under the personal direction of its founder, and while virtually a private garden it was, except at certain stated times, always open to the public. Although popularly known as "Shaw's Garden" the name Missouri Botanical Garden was designated by Mr. Shaw as its official title and in his will or in any of his writings he specifically referred to it as the "Missouri Botanical Garden." By a provision of Mr. Shaw's will the Garden passed at his death into the hands of a Board of Trustees. The original members of the Board were designated in the will, and the Board so constituted, exclusive of certain ex-officio members, is self-perpetuating. By a further provision of the will, the immediate direction of the Garden is vested in a Director, appointed by the Board of Trustees. The Garden receives no income from city or state, but is supported entirely from funds left by the founder.

The city Garden comprises 75 acres, where about 12,000 species of plants are growing. There is now in process of development a tract of land of over 1,600 acres outside the city limits which is to be devoted to (1) the propagation and growing of plants, trees, and shrubs, designed for showing either indoors or outside, at the city Garden, thus avoiding the existing difficulties of growing plants in the city atmosphere; (2) gradually establishing an arboretum as well as holding a certain area as a forest reservation, with the idea that possibly at some future time this may become the new botanical garden.

The Garden is open to the public every day in the year, except New Year's Day and Christmas—week days from 8:00 a. m. until sunset; Sundays from 10:00 a. m. until sunset.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Place, on the Sarah car line (No. 42). Transfer south from all intersecting lines.

STAFF
OF THE MISSOURI BOTANICAL GARDEN

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Hove, Sussex, England

MISSOURI BOTANICAL GARDEN BULLETIN

Vol. XXIV FEBRUARY, 1936 No. 2

CONTENTS

	Page
Plant Propagation	45
Notes	63
Statistical Information	66

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Missouri Botanical Garden Bulletin

Vol. XXIV FEBRUARY, 1936 No. 2

PLANT PROPAGATION

All plants, from the giant redwoods of the forest down to the microscopic but potent bacteria, have one or more methods of propagation, otherwise they would soon become relics of the past. These methods of reproduction vary with different kinds of plants. One of the simplest is a form of budding practiced by yeast, the tiny plant which is so important in the baking industry and in the manufacture of alcoholic beverages. Under favorable conditions mature cells form buds which soon become separate and independent cells (fig. 1). More complex plants, such as the

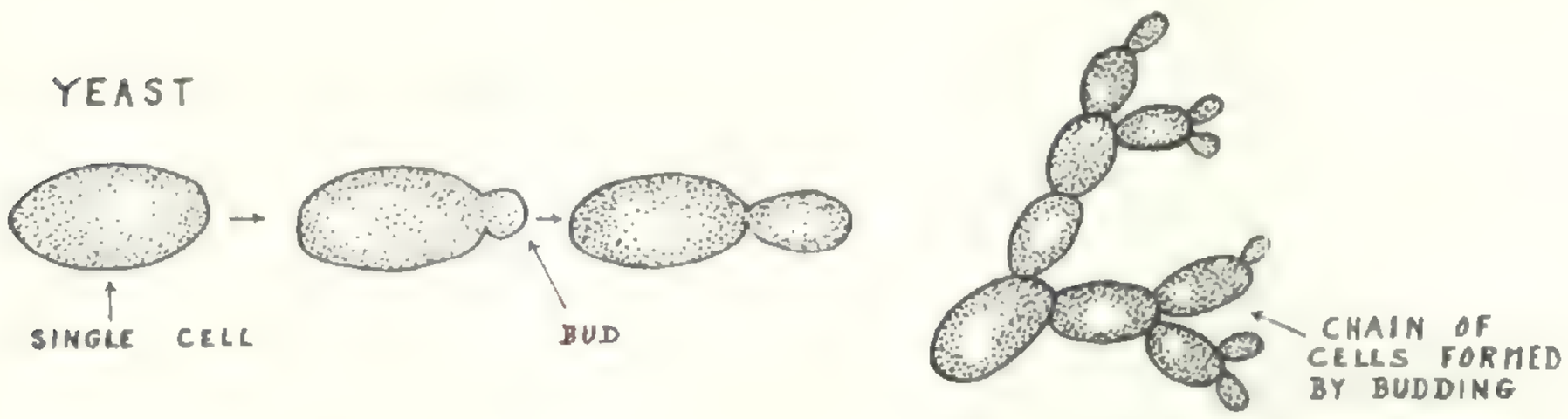


Fig. 1. Propagation of yeast by budding.

ferns, generally propagate by spores (not seeds) produced in spore cases on the underside of the frond or leaf. These spore cases are often mistaken for insects and many perfectly respectable ferns come to an untimely end on the trash pile. The life cycle of a fern is somewhat as illustrated in fig. 2. Flowering plants increase by seeds and vegetative methods, i.e. by rhizomes, runners, suckers, tuberous roots, bulbs, viviparous leaves, etc. It

is with these vegetative methods of reproduction that the present article is concerned.

Although nature has thoughtfully provided a number of ways for plant regeneration, man has found them inadequate when it comes to reproducing the desirable characters of many hybrids he has created. For instance, varieties of iris, peonies, delphiniums, dahlias, roses, and geraniums do not come true to color, size or shape when raised from seed, but if propagated by division of

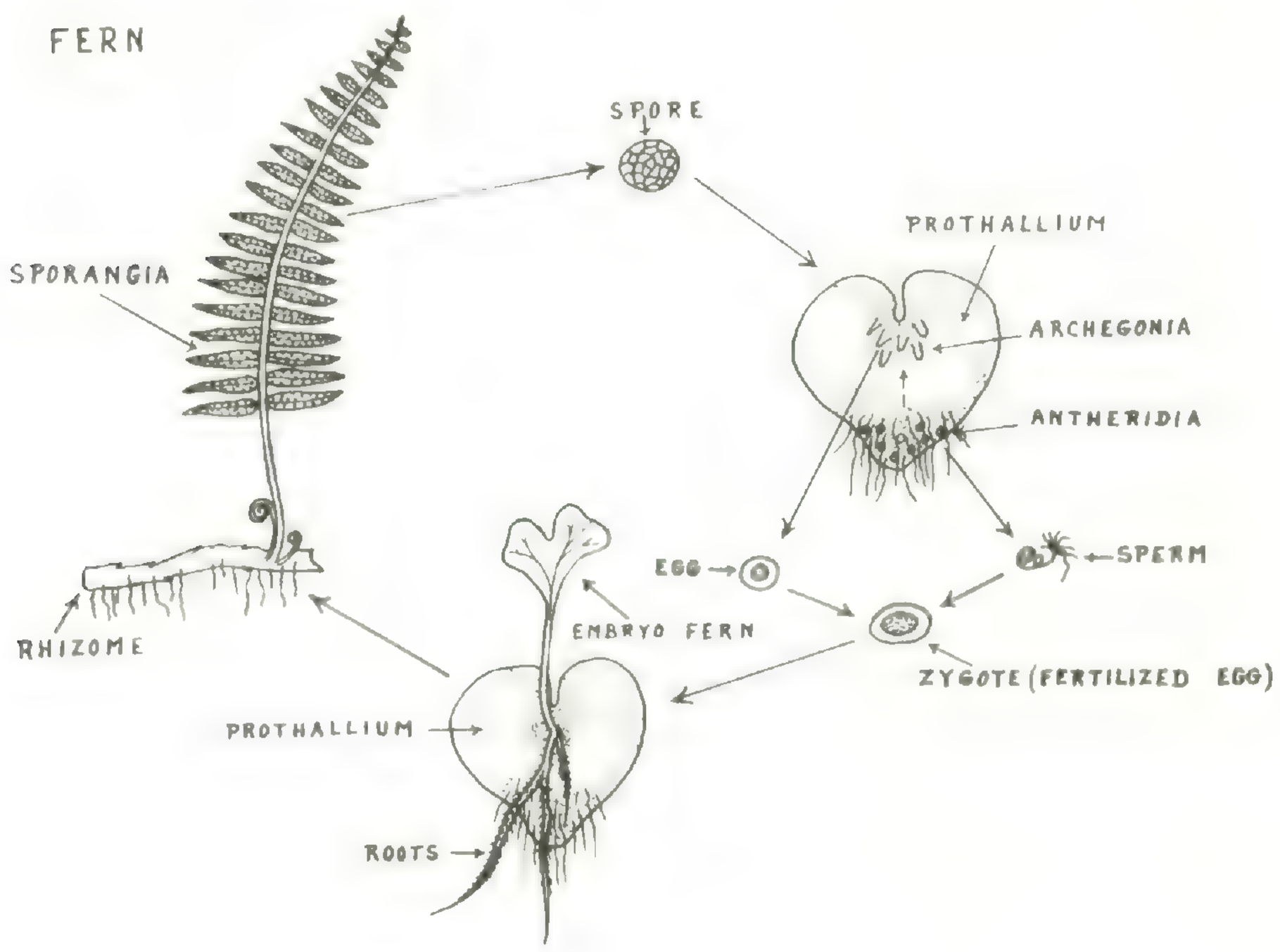


Fig. 2. Life cycle of a fern.

the clump, or by root and stem cuttings, all of the varietal characteristics are retained in the offspring. When plants have been so highly specialized by hybridization that they produce no seed, vegetative methods of increase must be adopted. The seedless grape and orange are common examples of this specialization, as well as many ornamentals which are infertile due to excessive doubleness of the flowers. Some plants produce good seed but they are so difficult to raise from seed that only the expert can devote the time and effort essential in their culture. Thus for

various reasons many ornamental and economic plants are best propagated by vegetative methods as indicated in the following outline, the choice of method being determined by the type of plant, the results desired, and the equipment available.

Stem	1. Cuttings A. Soft-wood B. Half-ripened wood C. Hard or dormant wood (1) Simple cutting (2) Heel cutting (3) Mallet cutting 2. Rhizomes 3. Runners 4. Offsets 5. Layers A. Simple B. Tip C. Serpentine D. Continuous E. Mound F. Air 6. Bulbs, bulbels, bulblets, scales 7. Corms, cormels 8. Tubers
Root	1. Cuttings 2. Suckers 3. Tuberous roots
Leaf	1. Viviparous leaves 2. Leaf without petiole 3. Leaf with veins severed 4. Leaf divided into sections 5. Leaf with petiole 6. Leaf-bud cutting
Entire Plant	Division of clump or crown

Successful garden maintenance is hardly possible without some knowledge of plant propagation, yet it is surprising how many amateurs totally neglect this important subject. It is hoped, therefore, that the present article will show the value of vegetative reproduction and be of assistance to those who may wish to increase their favorite garden or greenhouse plants. For a detailed account of growing plants from seed, the reader is directed to the September, 1934, issue of the Garden Bulletin.

One of the first considerations is to determine how a certain

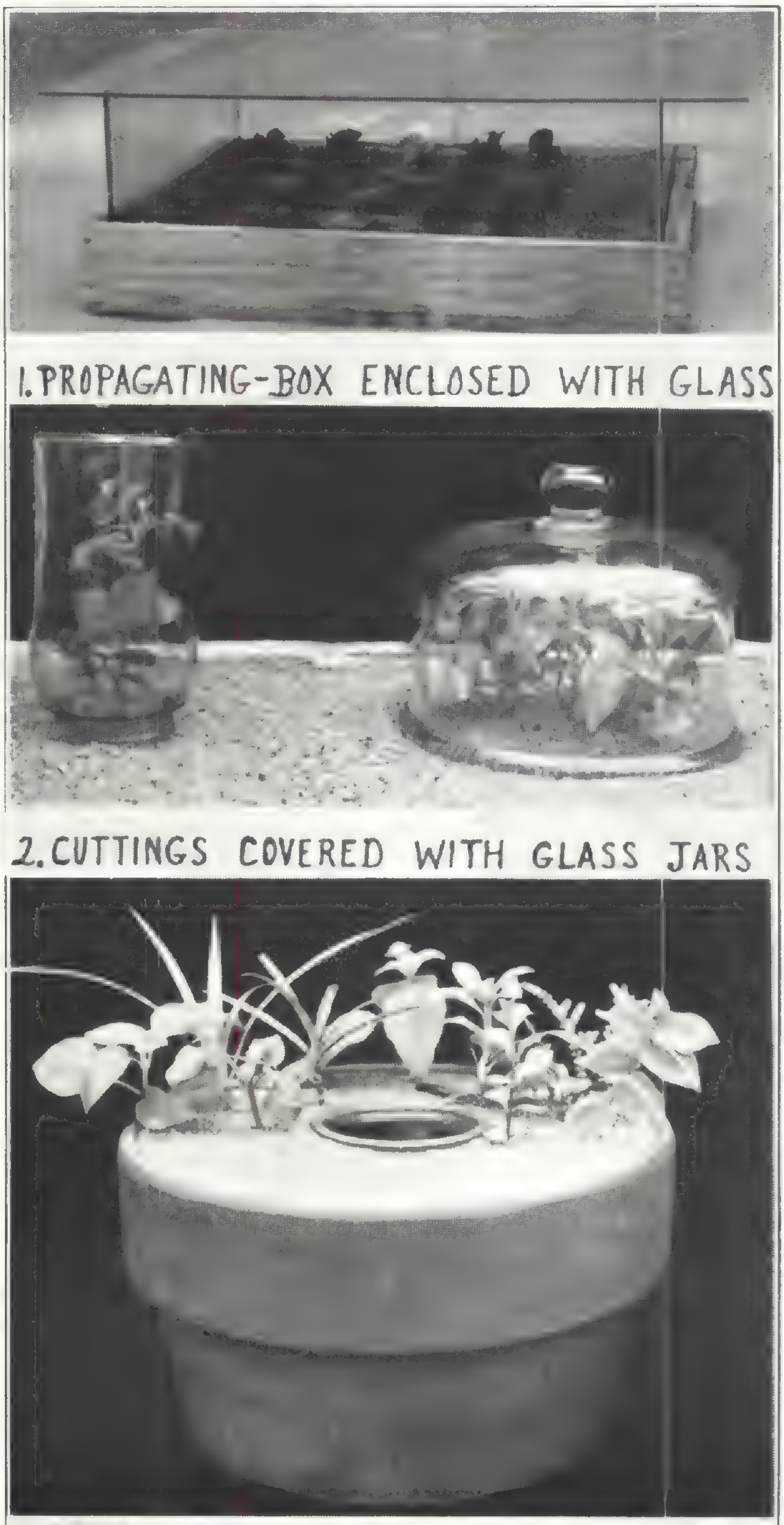
plant should be propagated, vegetatively or by seed. Such information can often be obtained by studying the plant in question, but mere observation is not always reliable, for the visible characters do not necessarily reveal the genetic constitution of the individual. In other words, a striking variety of gladiolus may set a fine lot of seed in auspicious plump pods, but it quite likely that only one seed in a thousand will produce a plant with a desirable flower. The gladiolus has been extensively hybridized, and invariably there is a strong tendency for the seedlings to revert to the ancestral types which are usually inferior. So the presence of seed is frequently an obscure detour sign for all except the pertinacious plant breeder.

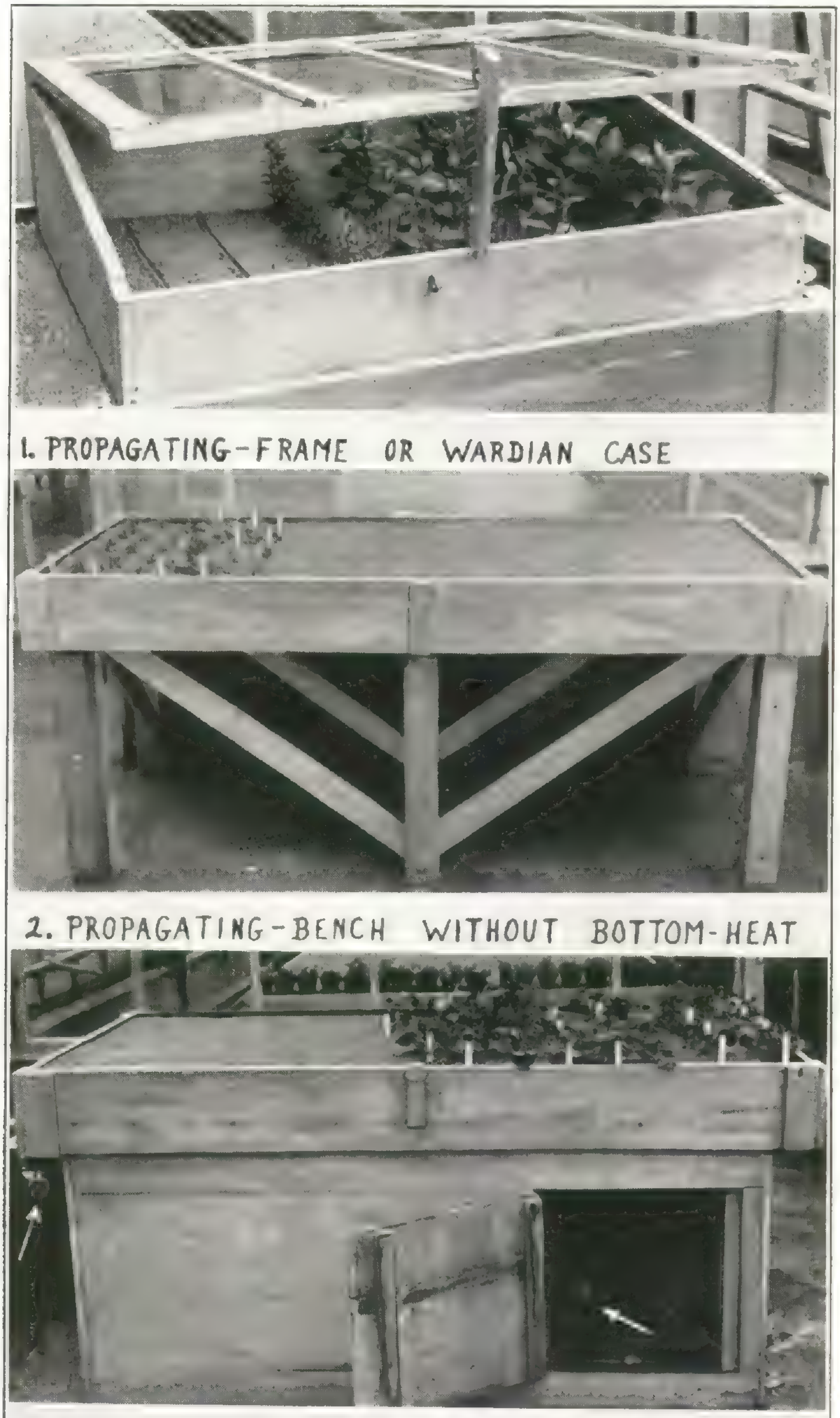
As a general rule propagation may be briefly summarized as follows (1) seed only—practically all annuals and biennials, (2) seed and vegetative methods—true species of perennials, (3) vegetative methods only—all hybrid varieties of perennials. To such a classification there are of course exceptions, but for the most part vegetative propagation is concerned with the hardy and tender perennials of garden and greenhouse. This includes all plants that live for over two years.

I. PROPAGATION BY MEANS OF STEMS

Cuttings.—A cutting is a piece of root, stem, or leaf which is able to continue growth and establish an entire new individual when detached from the rest of the plant. Propagation by this method is widely practiced commercially because it is a quick and economical way to increase stock. Many perennials supposedly do not respond to such treatment, but there is hardly any doubt that cuttings of all plants could be induced to form roots and shoots if provided with the proper conditions.

Success with cuttings depends largely on the methods of handling, the requirements varying with the different kinds of plants. Usually the cuttings do well if exposed to conditions favorable to the growth of the parent plant, but in certain cases special treatment is necessary, and even with the best of care, failures are apt to occur. The chances of error can be materially reduced if the right kind of plant material and equipment are used.


1. PROPAGATING-BOX ENCLOSED WITH GLASS
2. CUTTINGS COVERED WITH GLASS JARS
3. DOUBLE CUTTING-POT FOR HOME USE



1. PROPAGATING-FRAME OR WARDIAN CASE

2. PROPAGATING-BENCH WITHOUT BOTTOM-HEAT

3. PROPAGATING-BENCH WITH BOTTOM-HEAT

Plants.—Always select healthy, vigorous plants as stock for cuttings. Those blighted with disease or infested with insects should be avoided unless they are thoroughly cleansed of these parasites before using. Otherwise one is just courting trouble.

Rooting medium.—Soil, peat, sphagnum moss, sand, and water may be used in rooting cuttings. For outdoor work a light sandy loam gives fine results. Peat and sphagnum moss are used to advantage with certain types of cuttings and for layering. Rooting in water is also possible with some plants, but in the majority of cases clean sharp sand of moderately coarse texture is the best material to use. It permits good drainage and aeration which are beneficial to root formation.

Propagating-pots, cases, benches.—When only a few cuttings are to be rooted, an eight-inch bulb pan equipped with a small pot for irrigation purposes makes a convenient arrangement (pl. 9, fig. 3). A handful of broken crockery is placed in the bottom of the pan for drainage and the sand filled in around the small pot which has the hole at the base tightly corked. Water gradually seeps out of the small porous clay pot and keeps the sand uniformly moist. This is a very handy outfit for home use. A glass bell-jar placed over the cuttings will protect them from the harmful dry atmosphere present in most dwelling houses (pl. 9, fig. 2).

A shallow box or flat of sand, with a pane of glass on each side and on top to conserve the moisture, makes a fine propagating-case (pl. 9, fig. 1). An aquarium containing several inches of sand and fitted with a glass cover will serve the same purpose. With such equipment one can carry on an interesting form of gardening in the home during the winter months. The propagating-case or pot should be placed where the cuttings can have the benefit of sunlight. Slight bottom-heat from a steam or hot-water radiator will stimulate root action.

In the greenhouse, propagating-benches are used for cuttings. Steam or hot-water pipes are usually placed under the benches to control the temperature of the sand. Some cuttings are almost impossible to root without this bottom-heat. Two small benches of simple construction are illustrated in pl. 10, figs. 2 and 3. One

bench has the base entirely enclosed with boards to conserve the heat from the steam pipes which are about one foot below the floor of the bench. The top compartment contains sand to a depth of eight inches, with an inch of gravel on the bottom to prevent the sand falling through the drainage cracks between the floor boards. The spaces between the boards are best covered with window screening to keep the gravel in place. The other bench illustrated is of similar construction except that it lacks the steam pipes and therefore the temperature of the sand is determined by the temperature of the surrounding atmosphere. Such a bench is useful for cuttings that root well without bottom-heat.

When a confined moist atmosphere is needed for rooting, a box or frame is placed on top of the bench (pl. 10, fig. 1). Certain kinds of cuttings will not root unless given the protection of a frame where draughts can be avoided as well as variations in moisture and temperature. Bell-jars or any wide-mouthed glass container serve the same purpose on a smaller scale (pl. 9, fig. 2).

Cuttings of herbaceous perennials and woody plants are easily rooted outdoors if placed in a sash frame containing a well-drained, light, sandy soil. The frames require shading with lath or something to keep out the direct rays of the sun and prevent excessive evaporation during the summer.

Temperature, moisture, light.—The proper rooting temperature for different kinds of cuttings varies from 50° to 80° F. or over. For the majority of plants, however, about 65° to 70° F. is ideal. Root growth should accompany or precede top growth, and for this reason bottom-heat is applied to keep the sand 5 to 10 degrees warmer than the air. In frames outdoors this extra heat may be obtained from the soil or by several inches of fermenting manure placed under the substratum. The latest and best source of heat is electricity. Cables are stretched under the sand and a constant temperature maintained by thermostatic control.

Humidity is a very important factor in plant propagation and must be regulated to suit the kind of cuttings being handled. For example, cuttings of cacti and other succulents require a fairly dry environment. Too much moisture in the air or sand causes them to rot in a hurry. On the other hand, cuttings of many large-leaved conservatory plants demand the close humid atmosphere

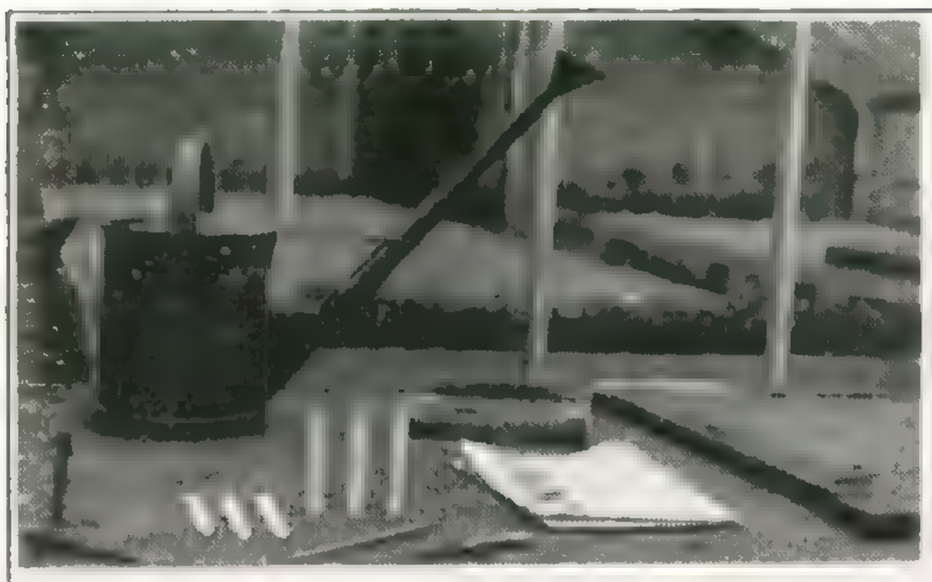
of a "Wardian Case" to root. If kept too dry, they collapse. For most of the common garden and greenhouse stock, moderately moist conditions are recommended. The sand should never be soggy nor dry. Sprinkle the foliage occasionally to keep the leaves firm.

When cuttings are first placed in the sand, they should be shaded from strong sunlight to avoid wilting, but as roots begin to form, more light can be admitted until finally they have established enough feeding roots to stand full sunlight. Keeping the cuttings in a shady place after the roots are well developed is a mistake. Without sufficient light, photosynthesis is retarded, causing the young plants to become spindly and weak. Fresh air is also essential, but avoid draughts.

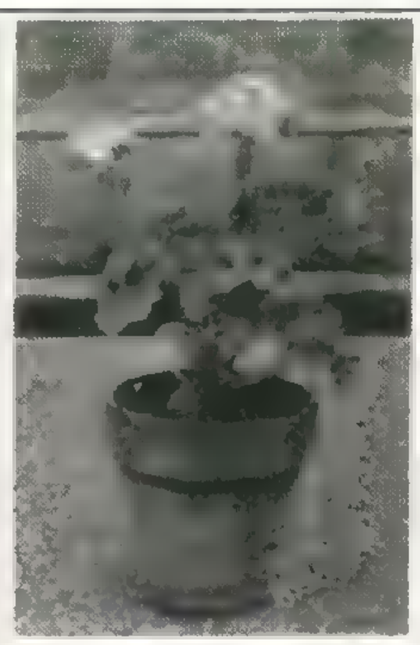
Tools, accessories.—Other equipment useful in plant propagation is shown in pl. 11, fig. 1. A sharp knife to trim off the cuttings, a tamping block to press down the sand, a straight-edge to mark off the rows if benches or cases are used, a dibble to make holes in the sand for the cuttings, wooden labels, a soft-lead pencil, a sprinkling can, newspaper for temporary shade, and a fair amount of patience are about all one needs except a basket to carry out the remains of the cuttings which obligingly play host to damping-off fungi. If you want to establish some first class cultures of disease fungi in and around your cuttings, proceed as follows:

1. Always use unsterilized equipment.
2. Use sand containing an abundance of organic matter.
3. Have sand well saturated with water.
4. Keep the air stale and moist.
5. Crowd cuttings closely together to prevent any possible air circulation.
6. Maintain a higher temperature than the plants require.
7. Exclude the direct rays of the sun.
8. Do not destroy dead or infected cuttings; leave them in the sand to spread the good news.
9. Never use any kind of fungicide.

If, after you have followed these directions carefully, you still have healthy-looking cuttings, send for Robert Ripley or take an I. Q. test as soon as possible.

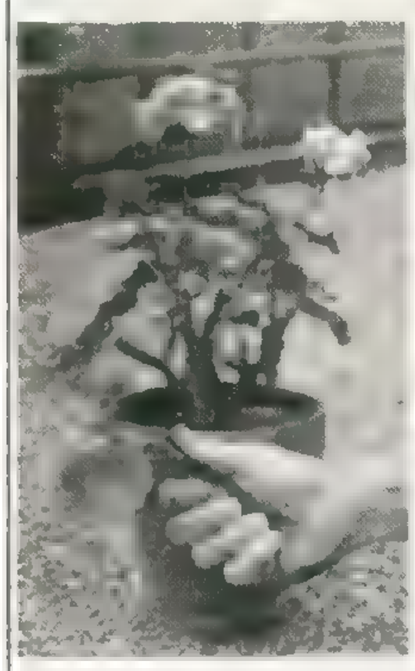


1. USEFUL EQUIPMENT FOR PROPAGATION



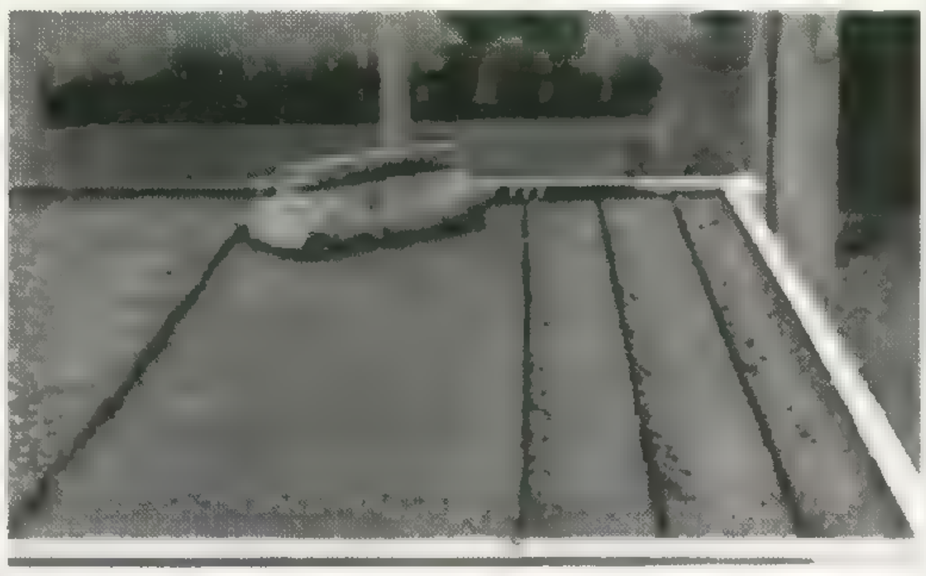
2. STOCK PLANT

3. TAKING THE CUTTING



4. CUTTING REMOVED

5. STOCK PLANT PRUNED

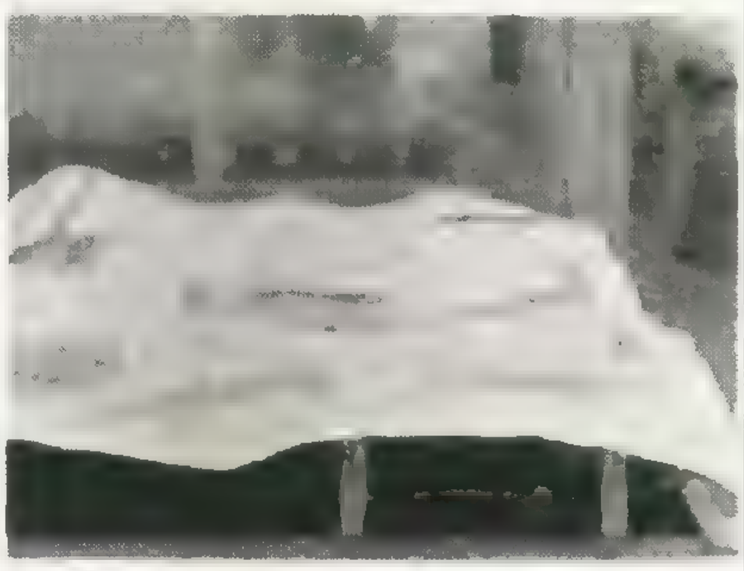


6. SAND TAMPED, ROWS MARKED OFF

7. CUTTINGS TRIMMED, READY TO GO IN SAND

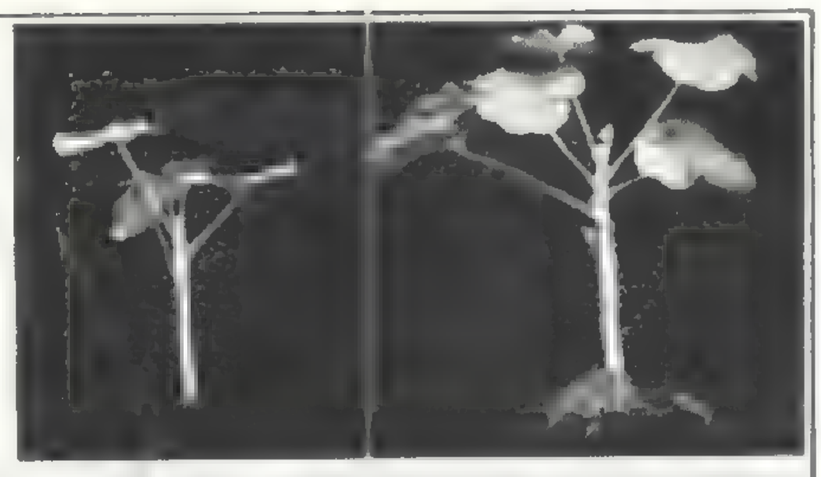
8. CUTTING FIRMED IN SAND

9. CUTTINGS SHOULD BE THOROUGHLY WATERED



10. SHADE FOR SEVERAL DAYS

1. REMOVING ROOTED CUTTING FROM SAND



2. UNROOTED AND ROOTED CUTTING

3. POTTING THE YOUNG PLANT

4. WATER, SHADE SEVERAL DAYS

5. STOCK PLANT, OFFSPRING

6. SOFT-WOOD CUTTINGS OF VARIOUS PLANTS

Soft-wood cuttings.—Stem cuttings may be separated into three general groups: (1) soft-wood, (2) half-ripened wood, (3) hard or dormant wood. To outline the various details of stem propagation by soft or green-wood cuttings which are commonly called "slips," let us consider the humble but indispensable geranium (pls. 11 and 12).

The stock plant from which the cuttings are to be taken should be healthy, vigorous, and well branched. The slips are made from wood that is brittle and snaps off readily when bent. Shoots of young succulent wood rot quickly in the sand, while old fibrous stems are always slow to root and produce inferior plants. Terminal or tip cuttings are generally preferred. The main shoots of some plants, such as the large-leaved rhododendrons which have considerable pith, are usually removed to force the development of lateral growths that have a greater proportion of wood and root more readily. Old plants can be "headed back" this way to get new lateral shoots for cuttings. Slips about four inches long are cut off the stock plant with a sharp knife. The leaves are removed from one or two nodes at the base of the cutting, but do not reduce the leaf area of the top unless it is excessively large and inconvenient. Leaves manufacture food which is necessary for the development of a new root system. If too many leaves are cut off the plant is liable to suffer from malnutrition, and in this weakened condition is more susceptible to damping-off fungi. The cuttings will naturally shed any excess foliage, so do not reduce the tops unless they are inconvenient or have a tendency to wilt badly.

All flower buds should be removed and the stem cut off clean just below the basal node. Geranium cuttings do better if lightly sprinkled with water and exposed to the air for several hours before being placed in the sand. This permits the wounded cells to heal over and discourages that pesky rot which specializes only on the best varieties! To prevent wilting most soft-wood cuttings are kept in a pail of water or wet newspaper until placed in the sand. Cuttings that have a milky sap are best dried for a few hours, like geraniums. The base of the cutting is inserted in holes or trenches made in the sand with a dibble, one or more nodes being covered to insure good rooting. Some propagators advocate pressing the slips into the sand without the aid of a dibble, but unless

one is very careful the plant tissues are apt to be injured. The sand should be firmed gently around the stem to avoid air pockets and the cuttings thoroughly watered. Shade with newspaper, cheese-cloth, or lath for about one week, and then expose to full sunlight. Keep the sand just moist.

A temperature of 70°–75° F. is favorable to rooting, and if possible use mild bottom-heat. In about three to four weeks the cuttings will form roots at least one-half inch long. The young plants should then be removed from the sand and potted up in a

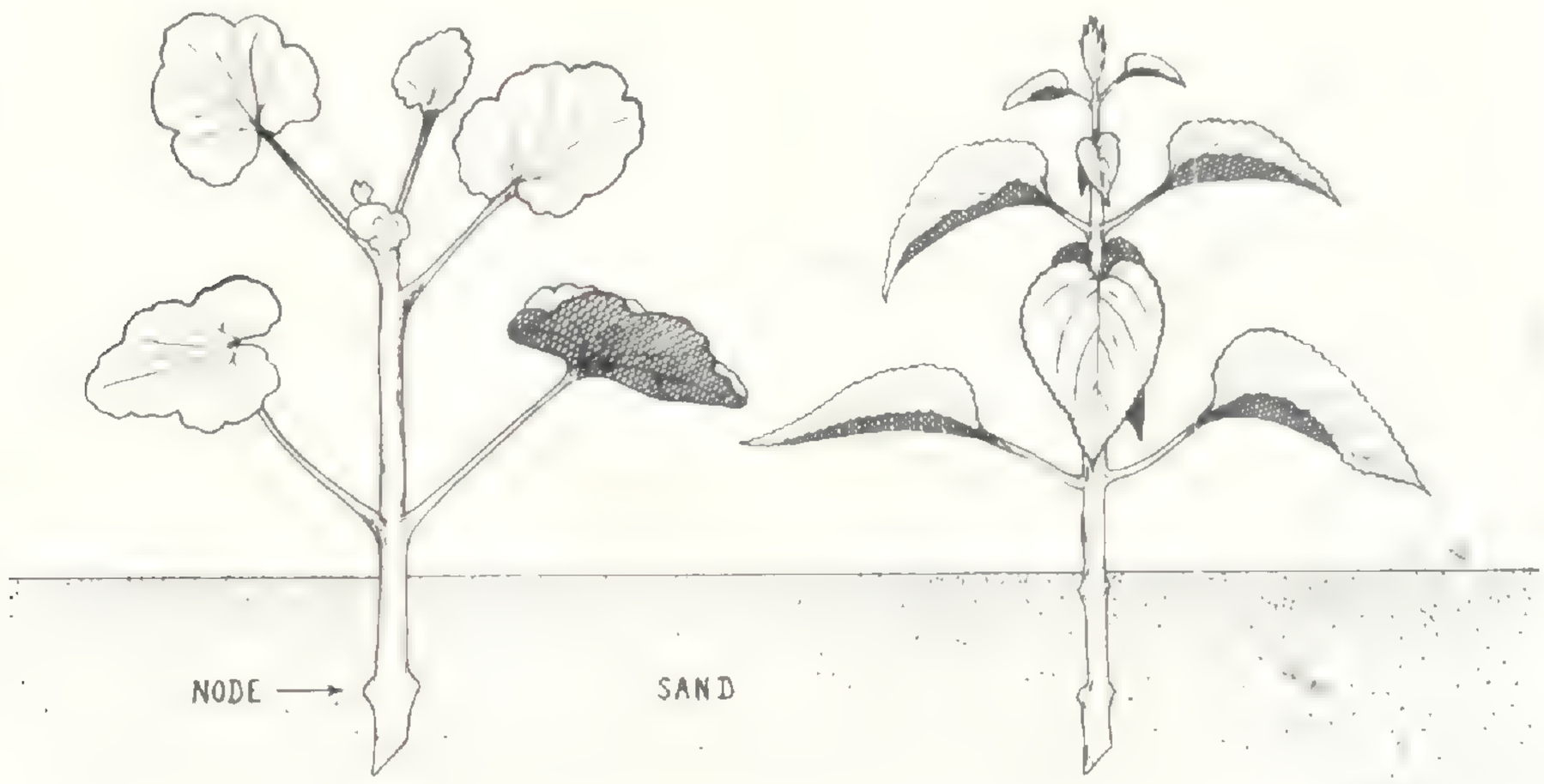


Fig. 3. Cuttings placed in sand.

heavy loam soil containing an abundance of organic matter (leaf mold, manure, compost, or peat). Water the plants well and shade for a few days until the roots become established.

House plants, as well as a large portion of the garden and greenhouse stock, are generally increased by soft-wood cuttings. A few examples are shown in pl. 12, fig. 6. Cuttings root differently at various times of the year. Tender plants can be propagated to advantage during fall and winter when the sunlight is not too intense and bottom-heat is available. Hardy herbaceous perennials are easily increased by this method in the spring when the plants have new shoots seven or eight inches tall. Select the stems which are firm, not too soft, and always leave a few buds on the stock plant

for future growth. Cuttings can also be rooted in summer if shaded from direct sunlight and watered properly.

PLANTS INCREASED BY SOFT-WOOD CUTTINGS

ANNUALS AND TENDER PERENNIALS

Abutilon—Flowering Maple
Acalypha—Chenille Plant
Ageratum—Floss-flower
Alternanthera
Antirrhinum—Snapdragon
Ardisia
Begonia semperflorens
Beloperone—Shrimp Plant
Buddleia—Butterfly Bush
Cacti
Chrysanthemum
Codiaeum—Croton
Coleus
Conservatory plants—many kinds
Crassula
Cuphea—Cigar Plant
Dahlia
Erica—Heather
Euphorbia—Poinsettia
Ficus elastica—Rubber Plant
Fuchsia—Lady's Ear-drops
Gardenia
Genista
Hedera—English Ivy
Heliotropium—Heliotrope
Hibiscus—Rose-mallow
Hydrangea
Impatiens
Ipomoea—Sweet-potato
Iresine—Blood-leaf
Lantana
Lobelia
Mesembryanthemum
Oplismenus—Variegated Grass
Pelargonium—Geranium
Philodendron
Pilea—Artillery Plant
Plumbago capensis—Leadwort
Salvia—Sage
Santolina—Lavender-cotton
Sedum—Stonecrop
Selaginella
Senecio confusus
Stevia
Strobilanthes
Succulents—many kinds
Swainsona
Tradescantia—Wandering Jew
Verbena
Vinca major—Periwinkle
Zebrina pendula—Purple Wandering Jew

Hundreds of hardy perennials can be propagated by soft-wood cuttings. A few of the more common ones are:

HARDY HERBACEOUS PERENNIALS

Althaea rosea—Hollyhock
Alyssum saxatile—Golden-tuft
Amsonia
Arabis—Rock-cress
Arenaria—Sandwort
Asclepias tuberosa—Butterfly-weed
Aster
Aubrieta—Purple Rock-cress
Boltonia
Campanula—Bellflower
Caryopteris
Centaurea Cyanus—Cornflower
Ceratostigma plumbaginoides—Blue Leadwort
Chrysanthemum
Clematis
Delphinium—Larkspur
Dianthus—Pink
Eupatorium coelestinum—Mist-flower
Gaillardia—Blanket-flower
Gypsophila—Baby's-breath
Helenium
Helianthus—Sunflower
Heliopsis—Orange Sunflower

Hesperis—Sweet Rocket
Heuchera—Coral Bells
Iberis—Evergreen Candytuft
Lobelia
Lychnis—Campion
Lythrum—Loosestrife
Mentha—Mint
Monarda—Horse-mint
Myosotis—Forget-me-not
Penstemon—Beard-tongue
Phlox
Polygonum—Fleece-flower
Potentilla—Cinquefoil
Ranunculus—Buttercup
Rudbeckia—Coneflower
Salvia—Sage
Saponaria—Soapwort
Sedum—Stonecrop
Silene—Catchfly
Solidago—Goldenrod
Teucrium—Germander
Tradescantia—Spiderwort
Veronica—Speedwell
Viola—Pansy
Yucca—Adam's-needle

Summer cuttings of woody plants.—During the summer, two types of cuttings can be made from ornamental shrubs and other woody plants: (1) soft-wood from young shoots which have a texture similar to the stems of a geranium, (2) half-ripened wood that has nearly completed growth. Cuttings made from young green shoots are handled in the same manner as "slips," except that a frame or Wardian case is practically necessary for rooting.

The half-ripened wood cuttings with leaves attached quickly strike root and develop into well established little plants for setting out the following spring. The cuttings may be taken from May to September, the time depending on when the plant makes its new growth. A shaded sash frame outdoors or in the greenhouse is ideal for this purpose, but if only a few cuttings are to be rooted, a small box with a glass cover is satisfactory. Inverted fruit jars are also effective.

The cuttings should be about six inches long and just brittle enough to snap off when bent double. The tip ends of the shoots are commonly used, but in some cases other parts of the stem will also root. The leaves are removed from two or three nodes at the base of the cutting and a clean cut made just below the basal node. The lower portion is then buried in the sand several inches and the cuttings watered as usual. The frame should be covered tightly with sash to maintain a close humid atmosphere. An occasional spraying with water (in the morning) will help to prevent the foliage from wilting. Do not keep the sand too wet. The cuttings will generally root in four to six weeks, then they can be transplanted to nursery beds or placed in flats of soil and kept in the frames. The young plants are benefited by a protective mulch

during winter or they may be held over in cold-frames to avoid alternate freezing and thawing. In spring the plants can be moved to permanent quarters.

Summer cuttings are easily made of the following shrubs:

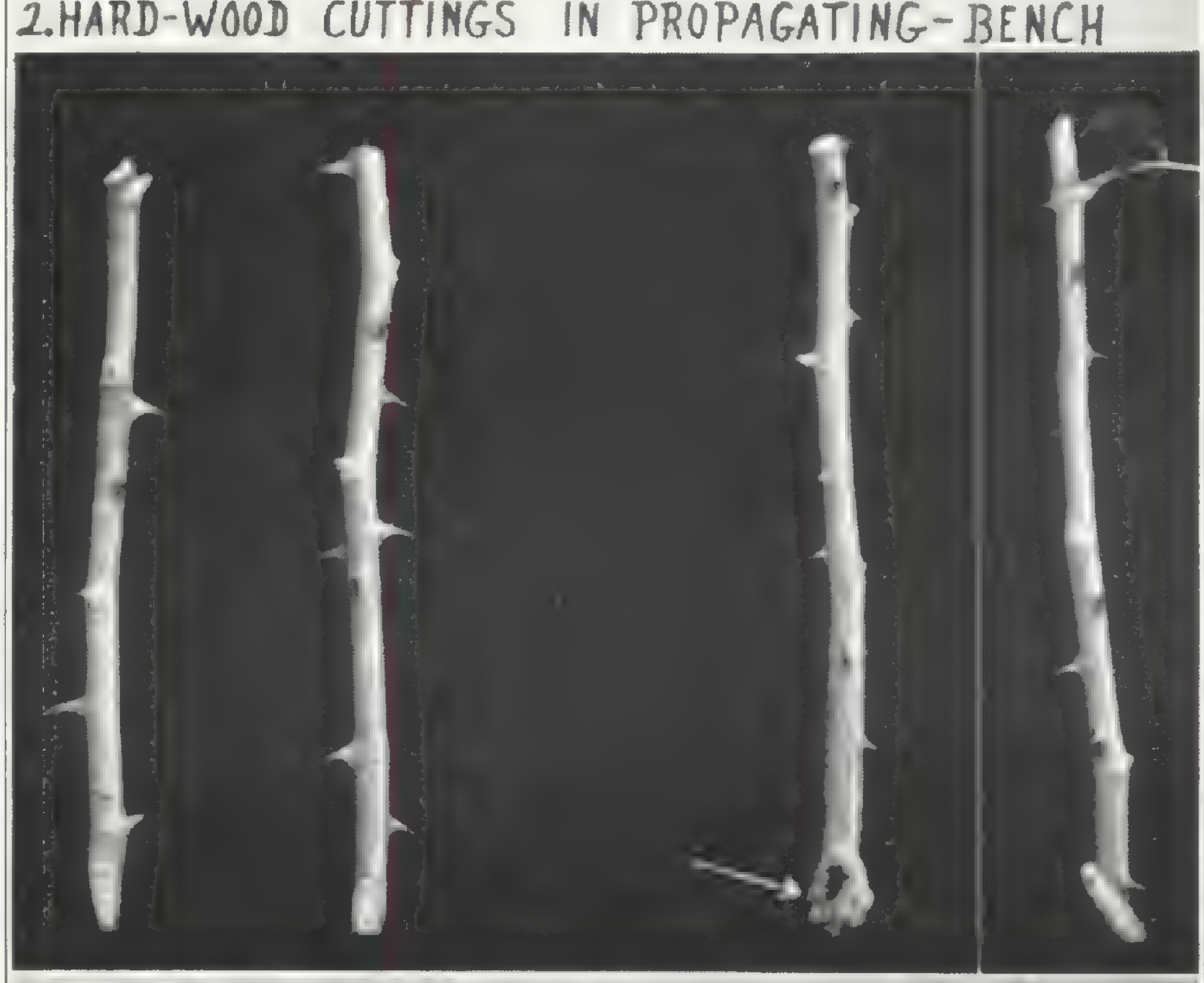
Abelia—Bush-arbutus
Acanthopanax—Five-leaf Aralia
Aronia—Chokeberry
Azalea
Berberis—Barberry
Buddleia—Butterfly-bush
Buxus—Boxwood
Calycanthus—Sweet-shrub
Chionanthus—Fringe-tree
Cornus—Dogwood
Cotoneaster—Rock-spray
Cytisus—Broom
Deutzia
Exochorda—Pearl-bush
Forsythia—Golden-bell
Hibiscus syriacus—Shrub-althea
Hydrangea
Kerria
Kolkwitzia—Beauty-bush
Ligustrum—Privet
Lonicera—Honeysuckle
Mahonia—Holly-grape
Philadelphus—Mock-orange
Rhodotypos—Jetbead
Spiraea
Symphoricarpos—Snowberry
Syringa—Lilac
Viburnum
Vitex—Chaste-tree
Weigela

Hard-wood cuttings.—Many shrubs, trees, and vines are propagated by this method. The cuttings are taken in the fall or during the winter when the wood of the previous season's growth is fully ripened and dormant. It is an advantage to take the cuttings in autumn as they will callus and often root before planting out in the spring. Some hard-wood cuttings can be planted outdoors in the fall in ordinary soil and will callus without difficulty if given slight winter protection. As a rule, however, the dormant shoots are cut up into pieces about six inches long and tied in convenient bundles with the tops all one way. The cuts are best made at or near the basal nodes and the lower buds rubbed off to prevent suckering when planted. The bundles are stored in boxes of moist sand, soil, or peat in a cool cellar. By the time spring arrives, the lower ends of the cuttings will have formed prominent calluses (pl. 13, fig. 3). The same results can be obtained outdoors by burying the bundles in sandy soil below the frost line. A mulch over the top of the soil will retard deep freezing.

In spring the callused cuttings are planted upright in the nursery row a few inches apart. The planting depth varies according to the nature of the cutting, but it is customary to leave approximately one-third of the stem above the soil, thus permitting one or several buds to develop into new shoots. In the fall the young plants can be moved as desired.

1. HARD-WOOD CUTTINGS OF POPLAR AND PRIVET

2. HARD-WOOD CUTTINGS IN PROPAGATING-BENCH



3 HARD-WOOD CUTTINGS OF ROSE SHOWING CALLUS

Short pieces of woody stem having only one eye or bud can frequently be used as cuttings. They should be started under glass with bottom-heat. The small pieces of stem are imbedded horizontally one inch deep in sand, the bud facing upward. When roots and shoots form, the young plants are potted up in soil and later set out in the field.

Various types of hard-wood cuttings are illustrated in figure 4. The heel and mallet types are useful with plants such as the evergreens which root very slowly. Cuttings of evergreens are

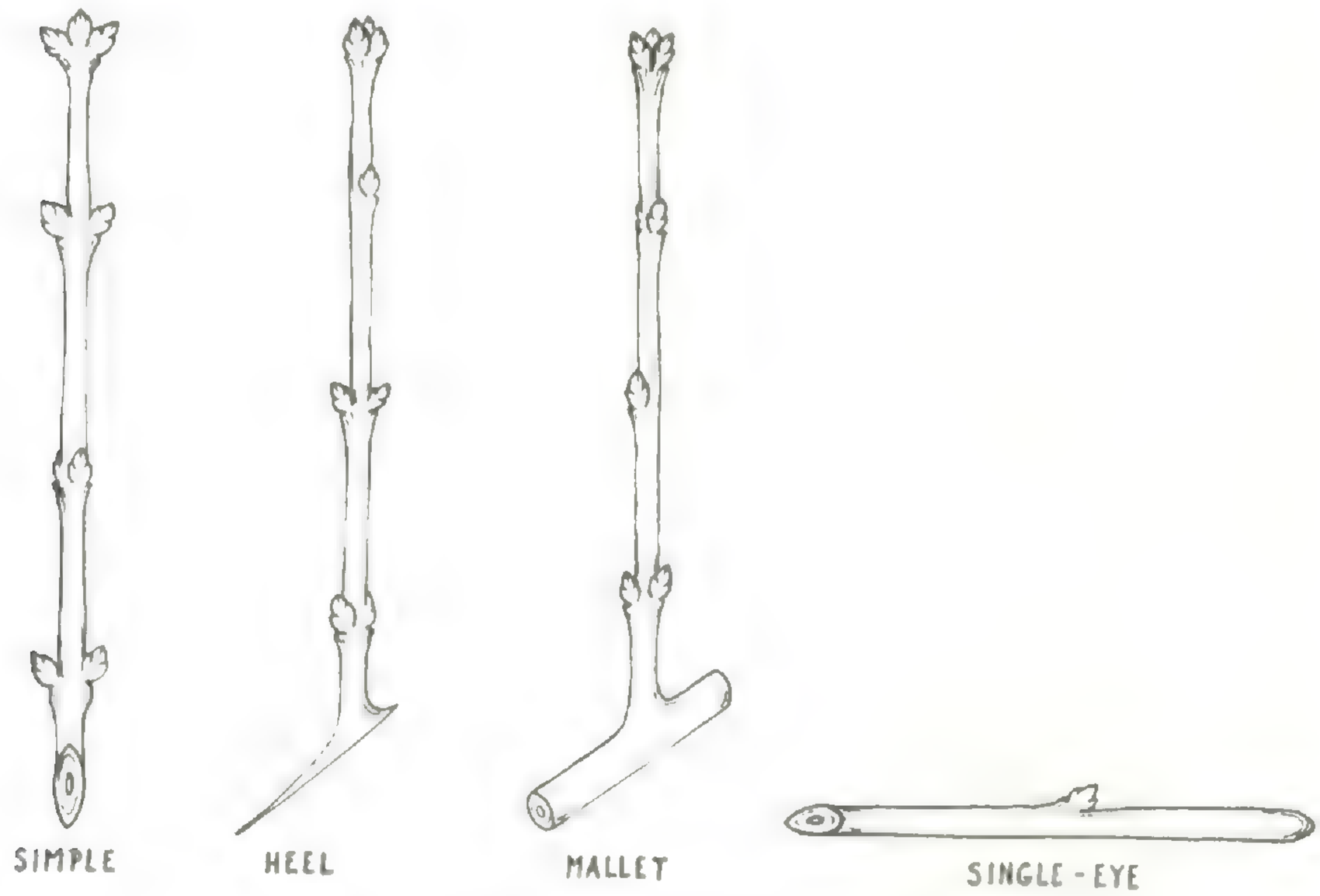


Fig. 4. Types of hard-wood cuttings.

handled in the same way as summer cuttings except that mature wood of the past season's growth is taken in fall after frost.

The following plants, as well as most of the shrubs mentioned in the foregoing list, are readily propagated by hard-wood cuttings:

Akebia
Ampelopsis—Virginia Creeper
Campsis—Trumpet Creeper
Catalpa
Cephalanthus occidentalis—Buttonbush
Chaenomeles—Flowering Quince
Crataegus—Hawthorn
Elaeagnus—Russian Olive
Euonymus—Burning-bush
Nerium—Oleander
Physocarpus—Ninebark
Populus—Poplar
Pyracantha—Firethorn

Rhamnus—Buckthorn
Rhus—Sumac, Smoke-tree
Ribes—Currant
Sambucus—Elder
Staphylea—Bladder-nut
Tamarix—Tamarisk
Vitis—Grape
Wisteria

D. C. F.

(To be continued)

NOTES

Dr. Carroll W. Dodge, Mycologist to the Garden, has been elected vice-president of the American Microscopical Society.

Mr. Paul A. Kohl, Floriculturist to the Garden, spoke before the Women's Club of Belleville, Ill., February 3, on "Roses."

Dr. David C. Fairburn, Research Assistant to the Garden, has a paper in *The Gladiolus,* the 1936 yearbook of the New England Gladiolus Society, on "The Gladiolus in Missouri."

The Gardeners' Chronicle of America (**40:** 48–49. February, 1936) contains an article by Mr. G. H. Pring, Superintendent of the Garden, on "Water-lilies."

Dr. David C. Fairburn, Research Assistant to the Garden, spoke before the nurses of the Deaconess Hospital, February 1, on "The Care and Arrangement of Flowers."

Mr. A. P. Beilmann, Arboriculturist to the Garden, gave an illustrated talk on "The Pruning of Shrubbery," before the Garden Club of St. Louis, February 10.

Dr. Edgar Anderson, Geneticist to the Garden, spoke before the Women's Council of the Union Avenue Christian Church, January 9, on "Science from the Inside."

Dr. Robert E. Woodson, Jr., Research Assistant to the Garden, is the author of an article in the January number of the *Bulletin of the Torrey Botanical Club* (**63:** 35–37) entitled "Additions to the Genus Amsonia."

The January, 1936, number of *Genetics* (**21:** 61–65) contains a paper by Dr. Edgar Anderson, Geneticist to the Garden, entitled "A Morphological Comparison of Triploid and Tetraploid Interspecific Hybrids in Tradescantia."

Dr. Hermann von Schrenk, Pathologist to the Garden, spoke before the meeting of the American Wood Preservers' Association, at Memphis, January 28, on "Toxicities of Creosote and Other Coal-Tar Products Extracted from Hard-wood Ties which Have Been in Track Twenty Years or More."

Mr. George H. Pring, Superintendent of the Garden, spoke before the St. Louis Ladies' Florist Club, January 5, on "The Evolution of the Chrysanthemum"; January 22, he gave an illustrated talk on "Water-lilies" before the seventh annual Nurserymen's and Landscape Gardeners' Conference, at Ohio State University, Columbus; and on February 4, before the St. Louis Hills Garden Club on "City Gardens."

Among the botanists using the Garden library and herbarium during the meetings of the American Association for the Advancement of Science, St. Louis, Dec. 30, 1935–January 2, 1936, were the following: Dr. J. M. Aikman, Associate Professor of Botany, Iowa State College, Ames; Dr. Caroline K. Allen, Assistant in the Herbarium, Arnold Arboretum, Boston, Mass.; Dr. George M. Armstrong, Head, Department of Botany, Clemson College, S. C.; Dr. Jens Clausen, Carnegie Institution of Washington, Stanford University, Calif.; Dr. E. E. Clayton, Pathologist, Bureau Plant Industry, U. S. Dept. Agr., Washington, D. C.; Dr. Clair F. Cox, Head, Department of Biology, Technical High School, Indianapolis, Ind.; Dr. George L. Cross, Assistant Professor of Botany, University of Oklahoma, Norman; Dr. Carl G. Deuber, Assistant Professor of Plant Physiology, Yale University, New Haven, Conn.; Dr. B. M. Duggar, Professor of Physiological and Applied Botany, University of Wisconsin, Madison; Dr. Ethel T. Eltinge, Assistant Professor of Botany, Mt. Holyoke College, South Hadley, Mass.; Dr. Carl C. Epling, Assistant Professor of Botany, University of California at Los Angeles; Dr. Norman C. Fassett, Assistant Professor of Botany, University of Wisconsin, Madison; Dr. Harry J. Fuller, Associate in Botany, University of Illinois, Urbana; Dr. J. C. Gilman, Associate Professor of Botany, Iowa State College, Ames; Dr. George J. Goodman, Instructor in Botany, University of Oklahoma, Norman; Dr. Edward H. Graham, Assistant Curator of Botany, Carnegie Museum, Pittsburgh, Pa.; Dr. M. L. Grant, Instructor in Botany, Univer-

sity of Minnesota, Minneapolis; Dr. Ada Hayden, Assistant Professor of Botany, Iowa State College, Ames; Dr. J. G. Horsfall, Associate in Research, N. Y. Agricultural Experiment Station, Geneva; Dr. O. E. Jennings, Curator of Botany, Carnegie Museum, Pittsburgh, and Head, Department of Botany, University of Pittsburgh; Dr. Theodor Just, Assistant Curator of Herbarium, University of Notre Dame, Notre Dame, Ind.; Dr. Catharine Lieneman, Instructor in Botany, Vassar College, Poughkeepsie, N. Y.; Dr. T. D. Mallery, Desert Laboratory of the Carnegie Institution of Washington, Tucson, Arizona; Dr. George W. Martin, Professor of Botany, University of Iowa, Iowa City; Dr. Mildred E. Mathias, Research Associate, New York Botanical Garden, N. Y.; Dr. Aven Nelson, Professor of Botany, and Mrs. Nelson, of the University of Wyoming, Laramie; Dr. Alice M. Ottley, Professor of Botany and Curator of the Herbarium, Wellesley College, Wellesley, Mass.; Dr. W. T. Penfound, Associate Professor of Botany, Tulane University, New Orleans, La.; Dr. L. J. Pessin, Associate Ecologist, Southern Forest Experiment Station, New Orleans, La.; Dr. H. W. Rickett, Associate Professor of Botany, University of Missouri, Columbia; Dr. Donald P. Rogers, National Research Fellow, Harvard University, Cambridge; Dr. C. O. Rosendahl, Professor of Botany, University of Minnesota, Minneapolis; Dr. Ward M. Sharp, Assistant Biologist, Division of Migratory Water Fowl, Bureau of Biological Survey, Valentine, Nebr.; Dr. Earl E. Sherff, Head, Department of Science, Chicago Normal College; Dr. R. A. Studhalter, Professor of Biology, Texas Technological College, Lubbock; Mr. Royal Turley, student, University of Montana, Missoula; Dr. Robert W. Webb, Senior Cotton Technologist, Bureau Agricultural Economics, U. S. Dept. Agr., Washington, D. C.; Dr. I. L. Wiggins, Assistant Professor of Botany and Curator of the Dudley Herbarium, Leland Stanford University, Calif.

More recent Garden visitors were Dr. Ralph W. Chaney, Research Associate, Carnegie Institution of Washington, and Professor of Paleontology, University of California, Berkeley; Mr. Francis B. Lincoln, Department of Horticulture, University of Maryland, College Park; Mr. Montague Free, Horticulturist, Brooklyn Botanic Garden, Brooklyn, N. Y.

STATISTICAL INFORMATION FOR JANUARY, 1936

GARDEN ATTENDANCE:

Total number of visitors	10,929

LIBRARY ACCESSIONS:

Total number of books and pamphlets bought	44
Total number of books and pamphlets donated	252

PLANT ACCESSIONS:

Total number of plants and seed packets donated	70

HERBARIUM ACCESSIONS:

By Purchase—

Killip, Ellsworth P.—Plants of Peru, collected by G. Klug	163
Pittier, H.—Plants of Venezuela	104
Verdoorn, Fr.—"Hepaticae Selectae et Criticae," Ser. IX, Nos. 401–450 inclusive	50
Verdoorn, Fr.—"Musci Selectae et Criticae," Ser. III, Nos. 101–150 inclusive	50
Williams, Louis O.—Plants of Wyoming, Colorado, Idaho, Washington and Oregon	957

By Gift—

Anderson, Edgar—Seeds of *Iris versicolor* L.	1
Barkley, Fred A.—Specimens of *Rhus* from Horticulture	1
Graham, Edward H.—Boraginaceae from Utah	20
Hagen, Stanley—Plants of Oklahoma	28
Hershey, A. L.—*Peganum Harmala* L. from New Mexico	3
Hinton, George B.—Plants of Mexico	5
Jennison, H. M.—Plants of Tennessee	3
Killip, Ellsworth P.—Plants of Peru	6
Moore, D. M.—Plants of Arkansas	8
Moseley, E. L.—*Halenia deflexa* (J. E. Smith) Griseb. from Michigan	1
Williams, Louis O.—Plants of western United States	104

By Exchange—

Demaree, Delzie—Plants of Ohio	105
Field Museum of Natural History—Miscellaneous herbarium duplicates	100
Total	1,712

SOME FACTS ABOUT THE GARDEN

The Missouri Botanical Garden was opened to the public by Mr. Henry Shaw about 1860. From that date to the death of Mr. Shaw, in 1889, the Garden was maintained under the personal direction of its founder, and while virtually a private garden it was, except at certain stated times, always open to the public. Although popularly known as "Shaw's Garden" the name Missouri Botanical Garden was designated by Mr. Shaw as its official title and in his will or in any of his writings he specifically referred to it as the "Missouri Botanical Garden." By a provision of Mr. Shaw's will the Garden passed at his death into the hands of a Board of Trustees. The original members of the Board were designated in the will, and the Board so constituted, exclusive of certain ex-officio members, is self-perpetuating. By a further provision of the will, the immediate direction of the Garden is vested in a Director, appointed by the Board of Trustees. The Garden receives no income from city or state, but is supported entirely from funds left by the founder.

The city Garden comprises 75 acres, where about 12,000 species of plants are growing. There is now in process of development a tract of land of over 1,600 acres outside the city limits which is to be devoted to (1) the propagation and growing of plants, trees, and shrubs, designed for showing either indoors or outside, at the city Garden, thus avoiding the existing difficulties of growing plants in the city atmosphere; (2) gradually establishing an arboretum as well as holding a certain area as a forest reservation, with the idea that possibly at some future time this may become the new botanical garden.

The Garden is open to the public every day in the year, except New Year's Day and Christmas—week days from 8:00 a. m. until sunset; Sundays from 10:00 a. m. until sunset.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Place, on the Sarah car line (No. 42). Transfer south from all intersecting lines.

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MISSOURI BOTANICAL GARDEN BULLETIN

Vol. XXIV MARCH, 1936 No. 3

CONTENTS

	Page
Plant Propagation (continued)	69
Notes	92
Statistical Information	93

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Missouri Botanical Garden Bulletin

Vol. XXIV MARCH, 1936 No. 3

PLANT PROPAGATION

I. PROPAGATION BY MEANS OF STEMS

(Continued from the February Bulletin)

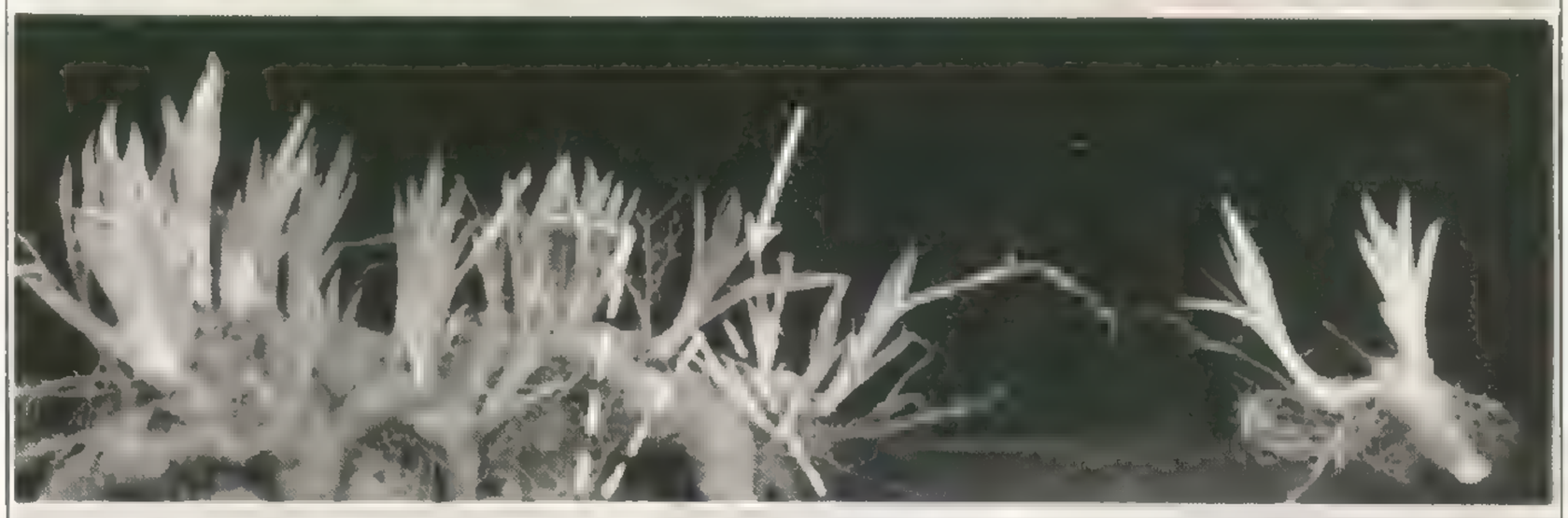
Rhizomes, runners, offsets, layers.—Some plants are propagated naturally and artificially by various kinds of stems which have become radically modified from the typical upright leafy forms. Many stems are weak and slender and lie prostrate on the ground where they frequently strike root, while others are climbers and support themselves on suitable objects. In certain cases they are partly or wholly subterranean, often being mistaken for roots. When stems normally contact the soil, they produce young plants of their own accord, but occasionally the process can be hastened by artificial methods.

Rhizomes or rootstocks.—A rhizome is an underground stem which generally bears roots, shoots, and leaves. Some rhizomes, such as those of certain Iris, are only partly subterranean, while others may penetrate rather deeply into the soil, as exemplified by the numerous slender rootstocks of plumbago *(Ceratostigma plumbaginoides)*. A rhizome is distinguished from roots by the presence of nodes, a true root having no such structures.

The German or common Iris is propagated by division of the rhizomes (pl. 14, fig. 3). A large clump is dug up and divided into a number of small pieces, each having two or three sprouts for new growth. These fragments, when planted separately in the garden, soon develop into sizable specimens. When the rhizomes

1. RHIZOME CUTTINGS OF CANNA

2. CANNA CUTTINGS IN PROPAGATING BENCH



3. DIVIDING RHIZOMES OF IRIS

are slender and bear no prominent shoots, they are cut up into short pieces and rooted in sand before planting outdoors (pl. 15, fig. 3). The cuttings are placed horizontally and covered with about one inch of sand or set upright with the lower portions embedded an inch or more in the sand. After roots and shoots have formed the young plants are potted up in soil and later transferred to the garden.

Unfortunately, two very pestiferous weeds, quack grass and bindweed (wild morning-glory), are propagated by rhizomes. Cultivation severs the rootstocks, and a new vigorous crop soon appears from these cuttings. For this reason they are very difficult to eradicate.

The following plants are propagated from rhizomes:

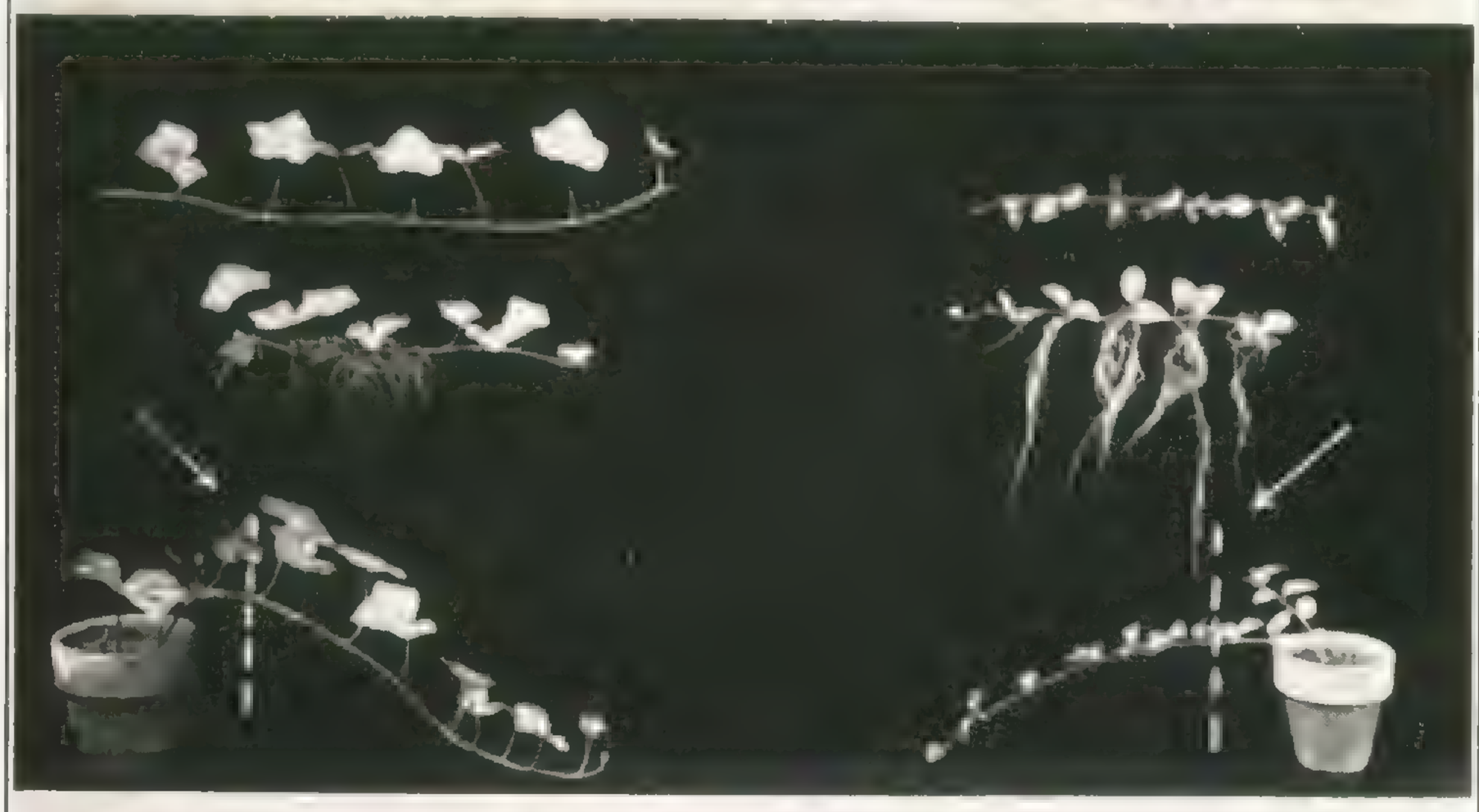
Achimenes
Agropyron—Quack Grass
Asarum—Wild Ginger
Aspidistra—Cast-iron Plant
Canna
Convallaria majalis—Lily-of-the valley
Convolvulus—Bindweed
Ferns—certain kinds
Helleborus—Hellebore
Holcus halepensis—Johnson Grass
Hosta—Plantain Lily
Iris—rhizomatous types
Narthecium—Bog Asphodel
Nymphaea—Hardy Water-lilies
Podophyllum—May-apple
Polygonatum—Solomon's-seal
Primula Seiboldi
Rheum Rhaponticum—Rhubarb
Sanguinaria—Bloodroot
Smilacina—False Solomon's-seal
Trillium—Wake-robin

Runners.—In some plants the stems are in the form of runners which creep along the surface of the ground and strike root at the nodes, producing new plants (pl. 17, fig. 1). Independence from the parent plant is established by the death or severance of the connecting stem after the offspring has developed roots and shoots. This method of increase permits the young plant to receive nourishment from the parent until it is able to shift for itself. Familiar examples of plants that propagate by means of runners are:

Fragaria—Strawberry
Nephrolepis—Boston Fern
Saxifraga sarmentosa—Strawberry Saxifrage

Offsets.—Many plants produce small rosettes or leafy shoots near the base of the parent plant. These offsets are sometimes attached to the parent by a short stem (pl. 23, fig. 5), but in other cases they cling directly to the main stem (pl. 22, fig. 5.). When

1. SELENICEREUS INCREASED BY STEM CUTTINGS



2. IVY AND VINCA STEM CUTTINGS

3. RHIZOME CUTTINGS OF PLUMBAGO

1. OFFSETS FROM WATER-LILY TUBERS

2. HARDY WATER-LILY, DIVISION OF RHIZOME

3. LILY-OF-THE-VALLEY, DIVISION OF RHIZOME AND FORCING PIPS

the offsets are borne next to the surface of the soil, it is an easy matter for them to strike root and eventually become independent. Offsets that do not contact the soil can be removed and placed in moist sand where rooting will occur in a short time.

The following plants increase by offsets:

Ananas sativus—Pineapple
Anthericum—St. Bernard Lily
Billbergia
Cotyledon
Echeveria
Eichhornia crassipes—Water-hyacinth
Marica
Pandanus—Screw-pine
Phoenix dactylifera—Date Palm
Pistia Stratiotes—Water-lettuce
Sempervivum—Houseleek
Tillandsia

Layers.—Sometimes the stems or branches come in contact with the soil and take root at the nodes while still attached to the parent. Many plants do this unaided, while others require the gardener's assistance. It is one of the simplest and most dependable methods of propagation and is known as layering. It is often successful when cuttings fail, being especially useful with hard-wood material. For example, rhododendrons are almost impossible from cuttings but respond well to layering.

There are several different types of layering. To make a *simple* layer, a branch is bent over to the substratum and partly covered with sand or soil, the tip end being left exposed. The branch is held in place by the weight of the material covering it or by some type of anchor. That portion of the branch which is to be buried should have all the leaves removed unless they are sufficiently long-stemmed to extend above the surface. With woody stems a short cut or notch is made at each node that is to be covered to stimulate root formation. The cut should be propped open with a match or toothpick. When the layer is well rooted, connection with the parent is severed, and the young plant removed. Layering outdoors is usually done in the spring and summer. Embed the young growing shoots in a light sandy soil and keep the soil moist at all times. In the greenhouse, plants can be layered any time during the year, using sand, peat, or soil as a rooting medium.

Tip layering is commonly used with black raspberries and similar plants. The canes are bent over in late summer and the tips anchored in the soil. Roots and shoots soon appear at the tips, forming new plants which are cut from the supporting canes

1. RUNNERS OF BOSTON FERN

2. OFFSET OF WATER-LETTUCE

3. ANTHURIUM INCREASED BY LAYERING CANES

4. SERPENTINE LAYERING OF SENECIO CONFUSUS

5. ACALYPHA CUTTINGS, ROOT DEVELOPMENT DEPENDS ON LEAF AREA

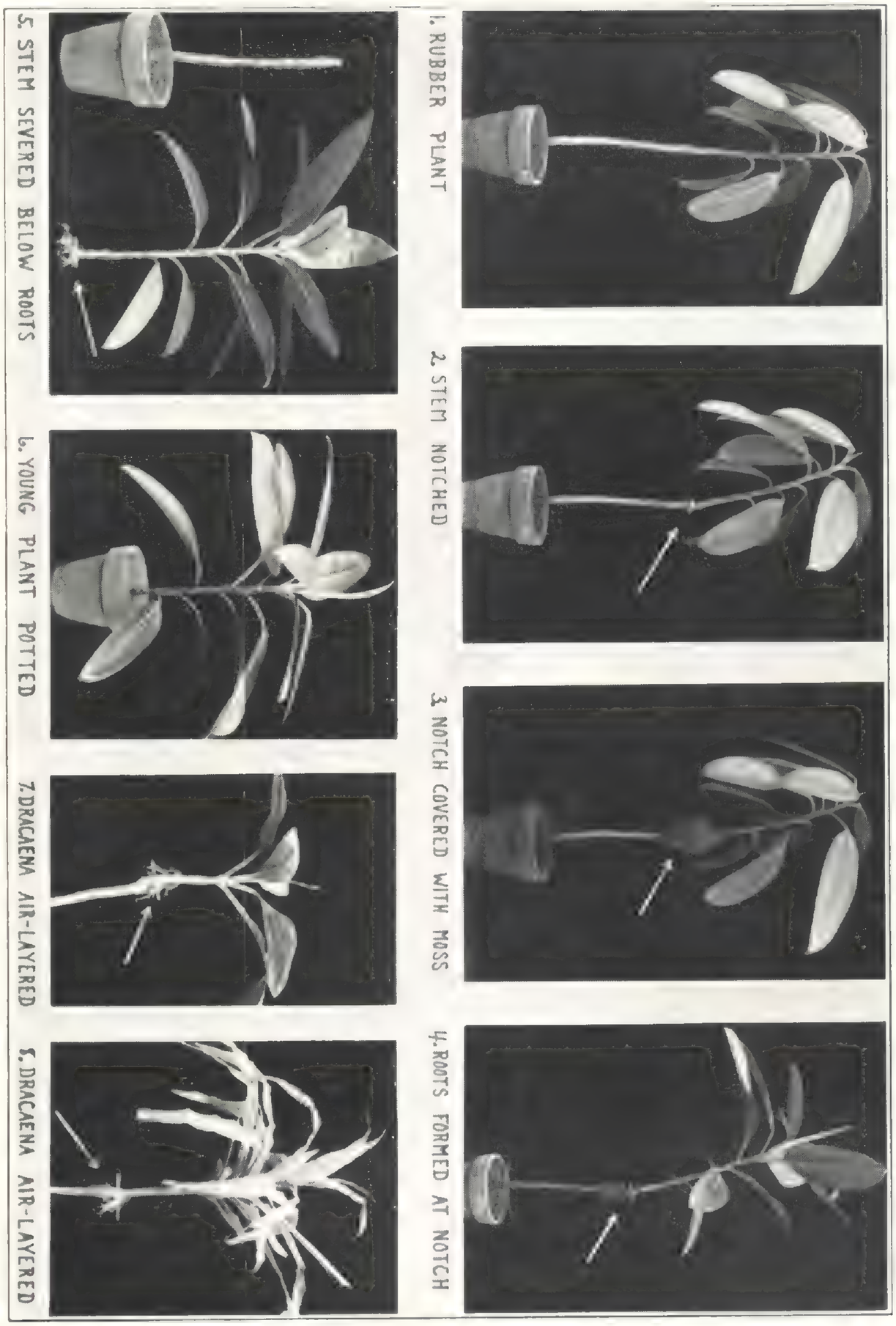
in the fall or spring and planted separately. Tip layering is illustrated in the following sketch (fig. 5).

Fig. 5. Propagation by tip layering.

Vines with long flexible stems are often propagated by *serpentine layers* (pl. 17, fig. 4). Alternate sections of a single stem are embedded in the sand or soil. Roots appear on each submerged scallop and a large number of plants are obtained.

In *continuous* layering, practically the entire branch except the tip is covered. This type is used with a limited number of vines and shrubs, since many plants will not develop shoots from buds which are covered with sand or soil. Ivy, willow and high-bush cranberry are easily propagated in this manner. Figure 6 shows a continuous layer of ivy.

Fig. 6. Propagation by continuous layering.


1. RUBBER PLANT
2. STEM NOTCHED
3. NOTCH COVERED WITH MOSS
4. ROOTS FORMED AT NOTCH
5. STEM SEVERED BELOW ROOTS
6. YOUNG PLANT POTTED
7. DRACAENA AIR-LAYERED
8. DRACAENA AIR-LAYERED

Mound layers are used to advantage with low-growing plants which have stems that are too stiff to bend satisfactorily. Gooseberries lend themselves readily to mound layering (fig. 7). The plants are pruned back severely to encourage branching at the base. Sandy soil is then mounded up around the new shoots which strike root at the nodes. The young plants develop rather

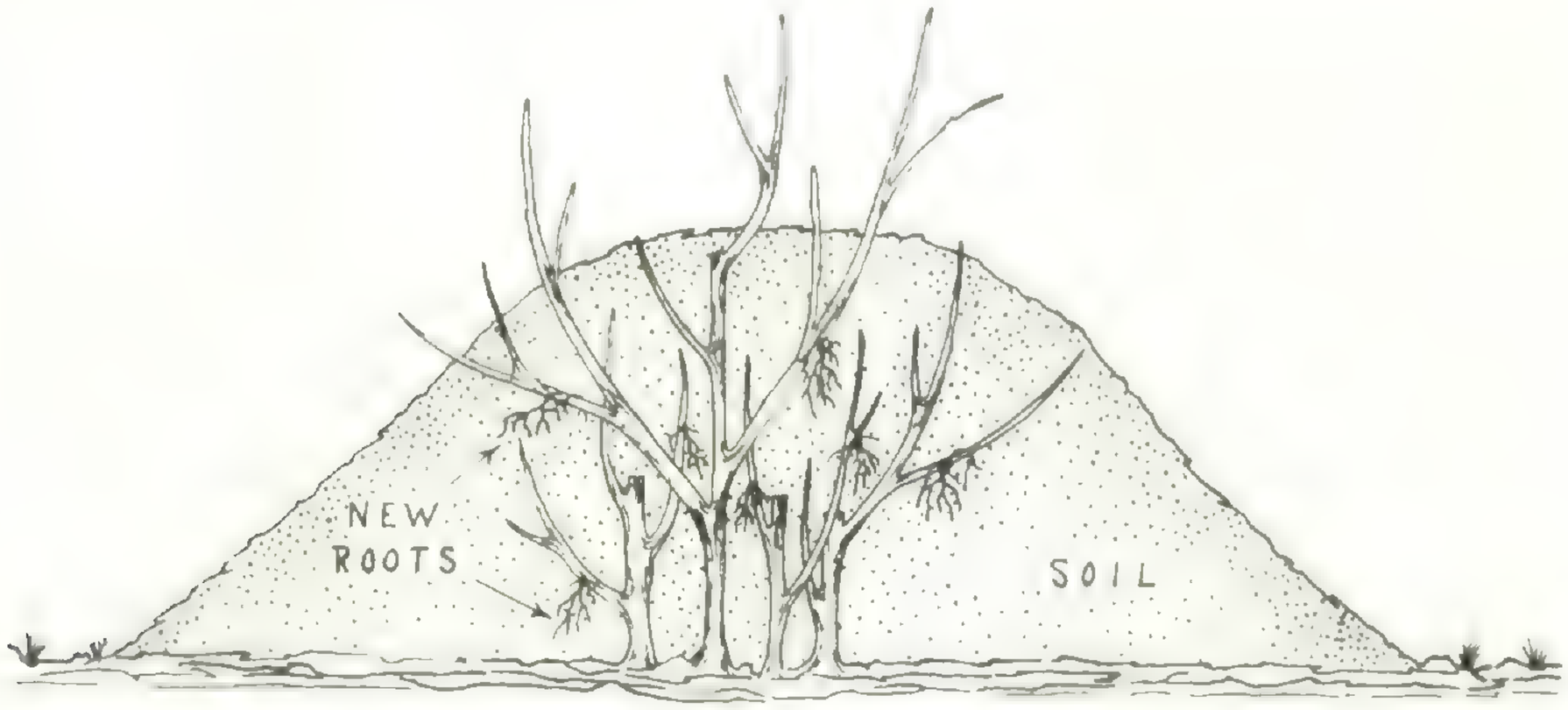
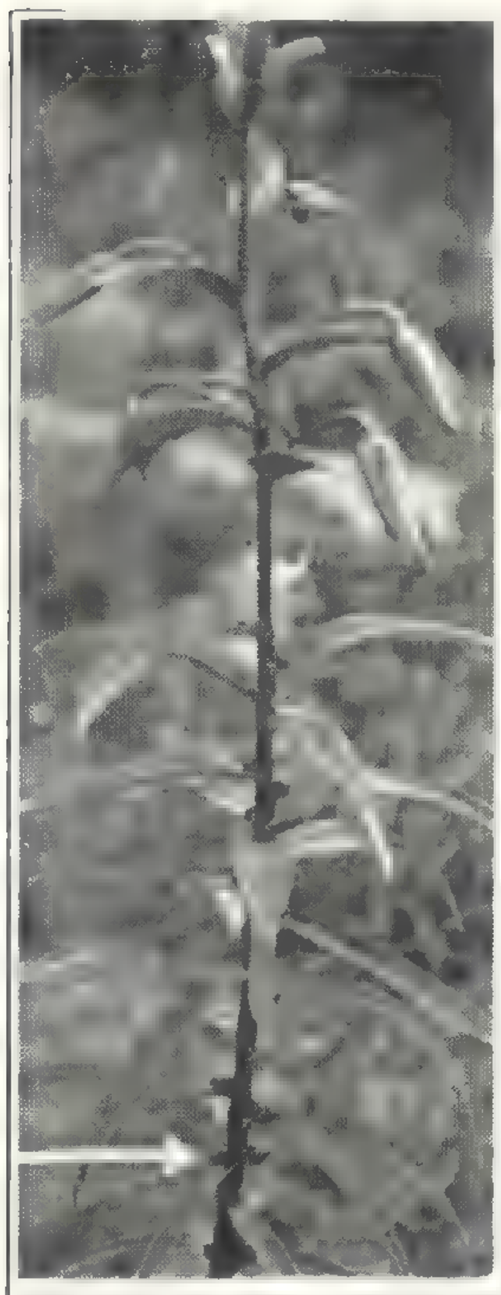


Fig. 7.

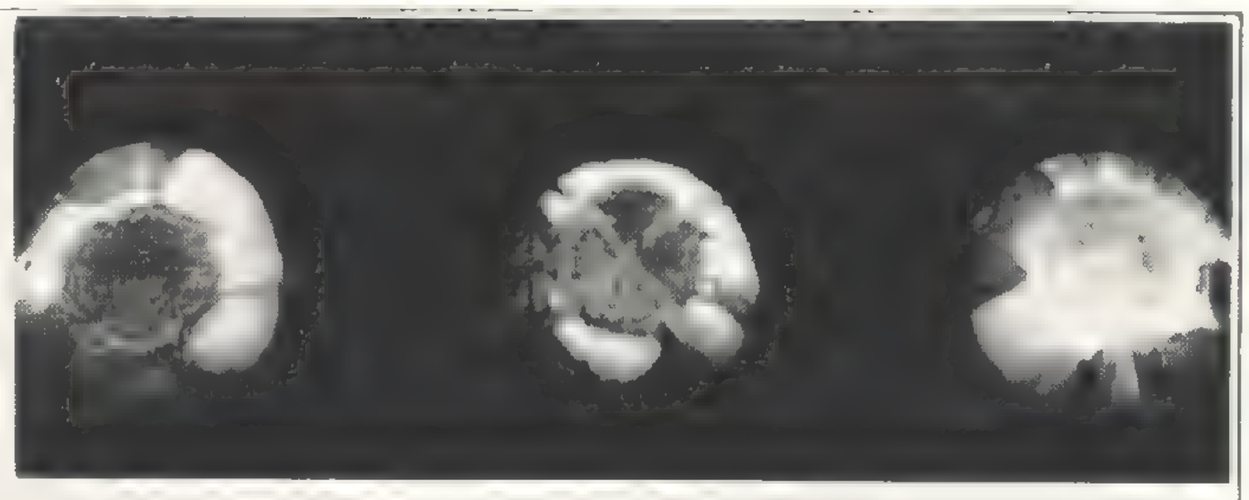
slowly, often requiring two years to establish a good root system. Other plants propagated by this method are:

Calycanthus—Sweet-shrub
Cotoneaster
Cydonia—Quince
Spiraea "Anthony Waterer"
Hydrangea

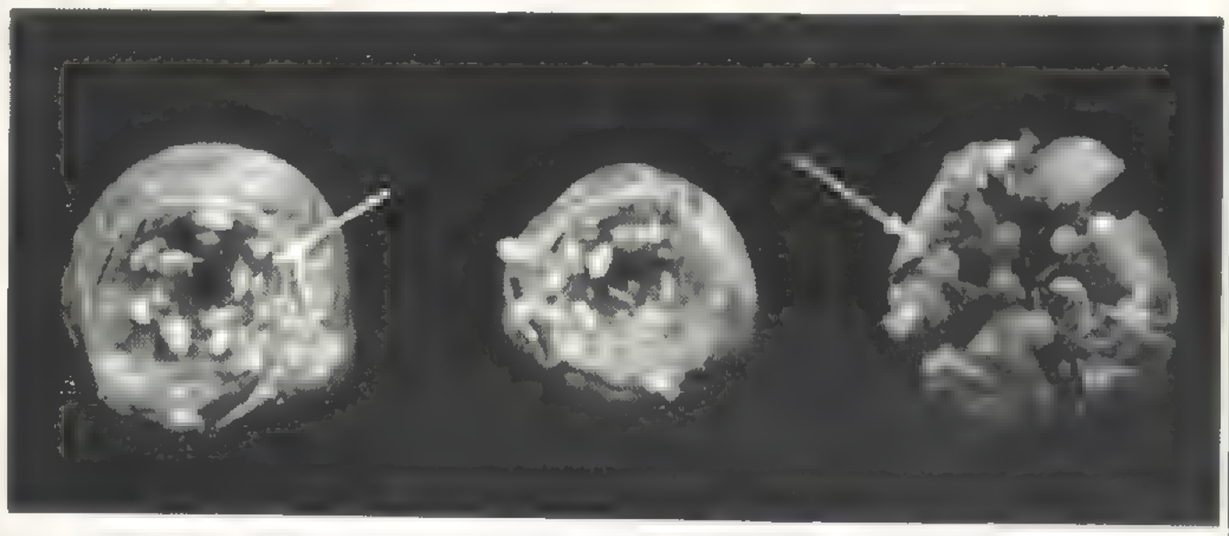
Greenhouse plants with rigid woody stems are often increased by Chinese or *air layering* (pl. 18). A slanting upward cut is made through one or more nodes on the stem and the cut propped open with a toothpick. A ball of damp sphagnum moss is then tied securely around the stem where the cut has been made. If the moss is kept moist and the plant exposed to a warm temperature, roots will soon form. The stem should then be cut off just below the ball of moss and the rooted section with moss intact potted up in soil to form a new plant. This is one way to reduce "leggy" or spindly plants to a desirable size. Another method is to cut the woody stems into short pieces and place them horizontally in damp moss or sand. Each piece will take root and form a new plant (pl. 17, fig. 3). Bottom-heat encourages rooting.



1. BULBLETS ON TIGER LILY

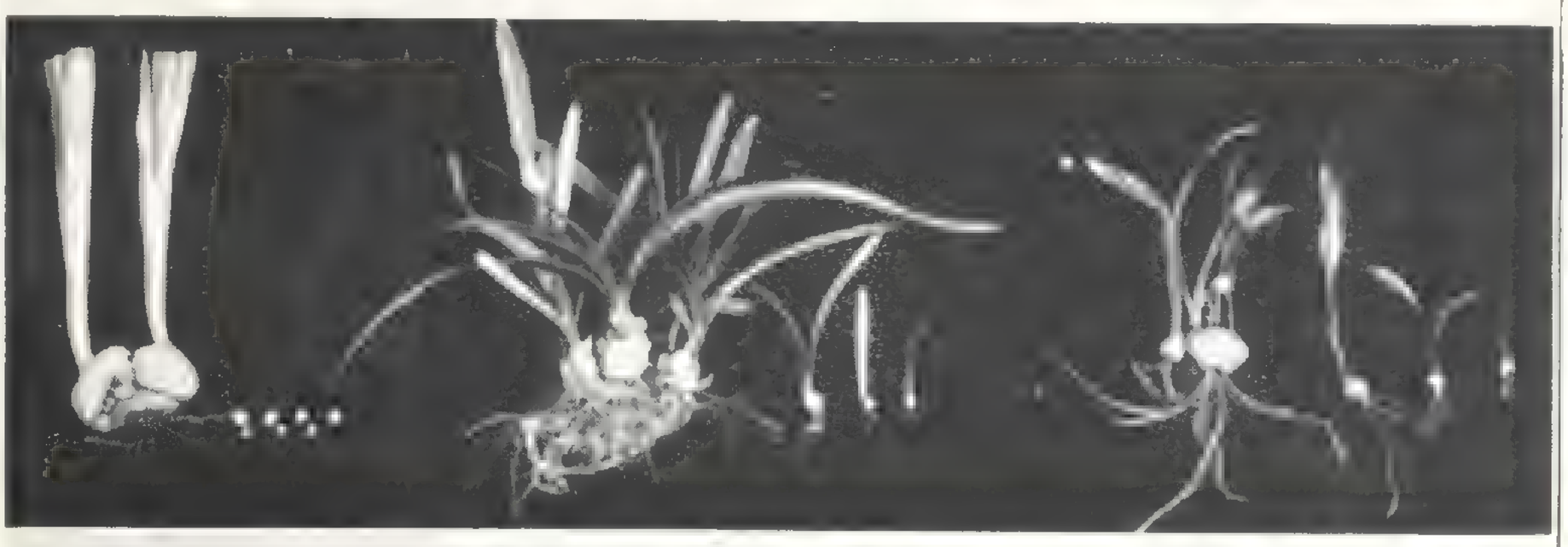


2. HYACINTH BULBS NOTCHED AND SCOOPED



3. BULBELS FORMING ON SCOOPED AND NOTCHED BULBS

4. LILIES INCREASE BY SCALES AND BULBELS



5. PROPAGATION OF GLADIOLUS, AMARYLLIS, LILY

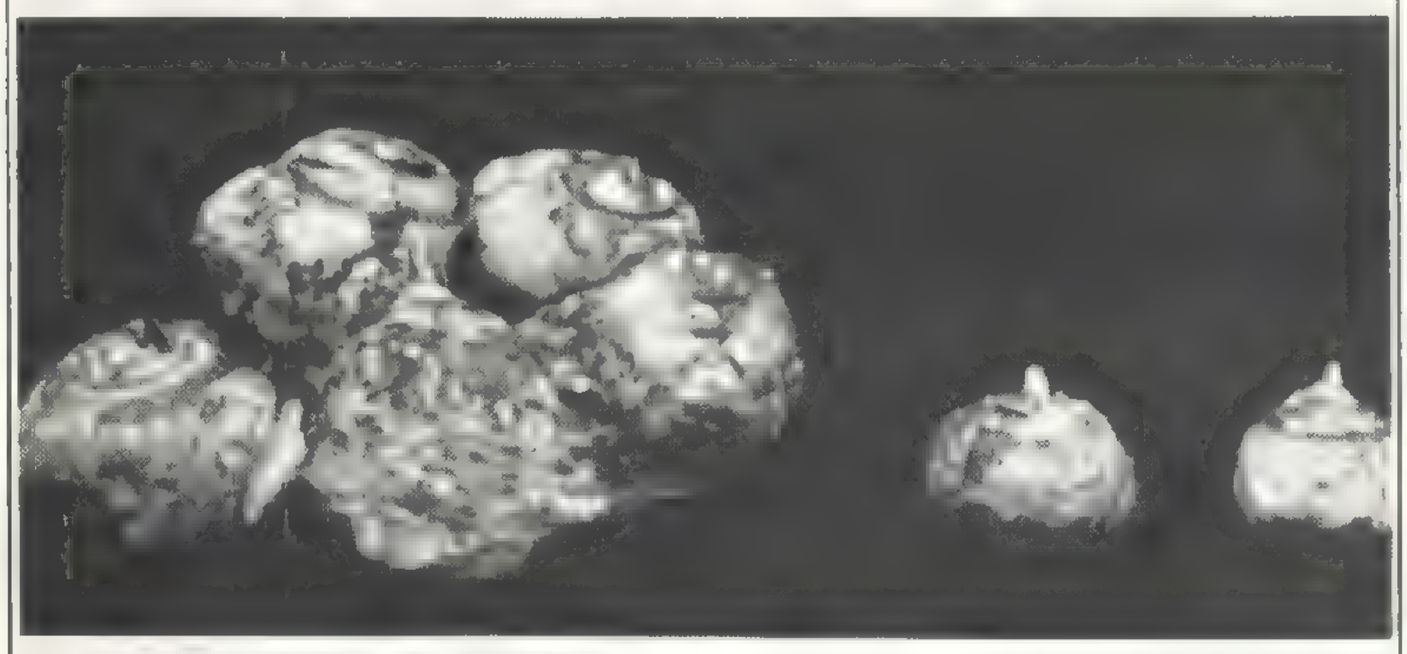
Bulbs, corms, tubers.—Many plants are propagated by bulbs, bulbels, bulb-scales, bulblets, corms, cormels, and tubers. These structures are simply modified stems and leaves which occur mostly underground. They contain large quantities of stored plant food, and under favorable conditions of moisture and temperature new plants are formed from dormant buds.

A *bulb* is a rounded underground structure composed mostly of fleshy scale-like leaves. There are two general types of bulbs: (1) tunicated, such as the onion, hyacinth, and tulip, which are composed of close-fitting layers of leaf tissue covered with a dry husk, (2) scaly, illustrated by the lily, which is made up of thick, loose, overlapping scales.

Bulbs are increased by natural separation. A mother bulb will produce one or more large bulbs or a number of small *bulbels*. If the bulbs are large enough, they will bloom within one year, but the small bulbels usually require several years to reach blooming size. When the mother bulb is dug, the bulbels are removed and replanted separately in pots, flats, or beds until they are large enough to produce flowers. Hardy bulbs, such as those of narcissus which increase rapidly, should be transplanted frequently to avoid crowding and subsequent non-flowering.

Hyacinths are propagated artifically by notching or scooping the bulbs when they are dug in spring and early summer (pl. 19, figs. 2 and 3). Making transverse cuts through the base of the bulb is known as notching. These cuts must not be too deep nor too shallow for good results. Any one not experienced in the art of making the notches will undoubtedly have some casualties. Scooping is also a delicate operation. The entire basal section of the bulb is removed in such a way that all the layers of scales are slightly severed. The wounded bulbs are dusted with slacked lime and placed bottom up in a moist chamber where the temperature can be maintained at 80° F. Within a few weeks small bulbels will start to form on the notched and scooped portions. The bulbs should remain in storage during summer and planted (with the young bulbels attached) outdoors in the fall. The bulbels then grow to maturity, being separated and replanted in special nursery beds the second year. Scooped bulbs produce more bulbels than notched ones, but they are small and require

1. TUBER CUTTINGS OF POTATO



2. CALLA TUBERS, DIVISIONS

3. TROPICAL WATER-LILY TUBER
SMALL TUBERS AT BASE

four to five years to reach flowering size. Notched bulbs form fairly large bulbels and flower in three to four years.

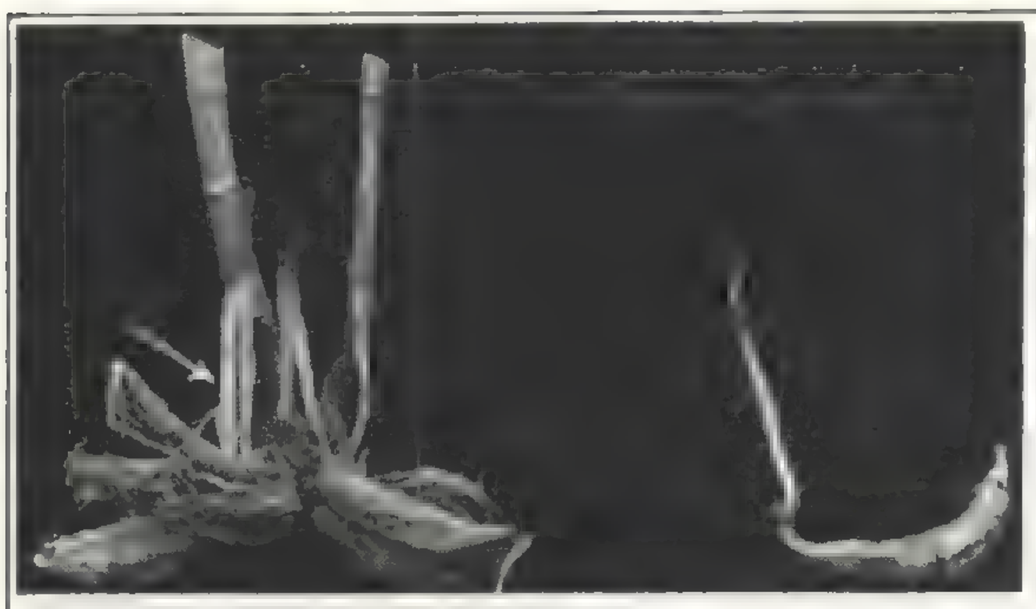
Lily bulbs are propagated by separation and are easily raised from the fleshy *scales* (pl. 19, fig. 4). Shortly after the bulbs have flowered, the scales are removed and placed in damp sphagnum moss in a warm greenhouse. Small bulbels will soon develop at the bases of the scales, and will flower in about three years. Another method is to plant the scales two inches deep in soil outdoors during the summer and leave them undisturbed until they flower some three years later.

A few plants produce *bulblets* on the stems in the axils of the leaves or in the flower cluster (pl. 19, fig. 1). When ripe these small bulblets drop off or are removed by hand and planted. Their culture is the same as for bulbels. In one to three years they will usually flower. Some of the plants increased by bulblets are:

Allium—Onion
Begonia Evansiana—Hardy Begonia
Ferns—certain kinds
Lilium (bulbiferum, Sargentiae, sulphureum, tigrinum)—Lily

The Madonna and several other lilies can be propagated from the lower part of the flower stem. After the flower has been cut off, the base of the stem is pulled out of the bulb and layered in sand. Small bulbs will arise from the prostrate stem and will flower in two or more years. Culture the same as for bulbels.

A *corm* is a rounded, fleshy, underground base of a stem. It is composed mostly of stem tissue, being solid like a potato, whereas a bulb consists mainly of leaf tissue and when cut open crosswise shows a number of concentric scaly rings. The gladiolus is a familiar plant that produces corms. Each year one or several new corms of flowering size are formed on top of the old mother corm which deteriorates at the end of the growing season (pl. 19, fig. 5). When the plant is dug in the fall, these new corms are separated and planted individually the following spring. Large corms may be cut into sections like a seed potato to produce more plants. *Cormels* are also formed at the base of the new corm. These cormels should be stored in fairly moist sand or soil until spring and then planted in rows like seed. In one to three years they will develop to blooming size.

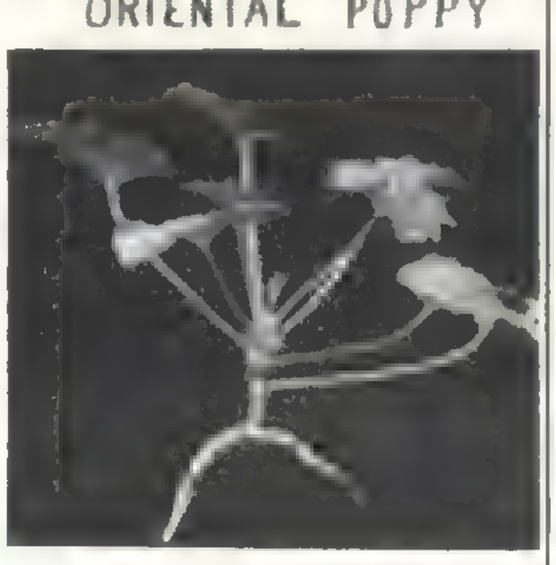


1. DAHLIA CLUMP, DIVISION WITH SPROUT

2. DIVISION OF DAHLIA ROOTS WITH BUDS

3. SWEET POTATO GROWING IN WATER, STEM CUTTINGS

4. ROOT CUTTINGS OF ORIENTAL POPPY



5. SUCKER ON GERANIUM ROOT

6. ROOT SUCKERS OF POPLAR TREE

7. SUCKERS OF ALOE

The following plants propagate by corms:

Calochortus
Crocus
Cyclamen
Ixia
Sparaxis
Tigridia
Tritonia
Watsonia

Some plants, such as the common Irish potato and the Jerusalem artichoke, reproduce by *tubers,* which are thickened underground stems bearing conspicuous buds. These tubers may be planted whole or cut up into several pieces, each piece having at least one healthy bud. Seed potatoes are usually divided into three or four sections which are planted separately. Each section produces a new plant (pl. 20, fig. 1).

2. PROPAGATION BY MEANS OF ROOTS

Cuttings.—Plants with thick fleshy roots can usually be propagated without difficulty from root cuttings (pl. 21, fig. 4). In certain cases, however, variegations are not transmitted by this method. The roots are cut up into pieces two or more inches long and planted horizontally about one inch deep in sand, moss, or soil. If bottom-heat is applied, new roots and shoots soon appear on the cuttings. Both hardy and tender plants can be propagated by this method in the greenhouse, but usually root cuttings of hardy stock are placed in pots or flats of sandy soil in the cold-frame over winter. In spring the small plants are well established and ready to be set out in the garden.

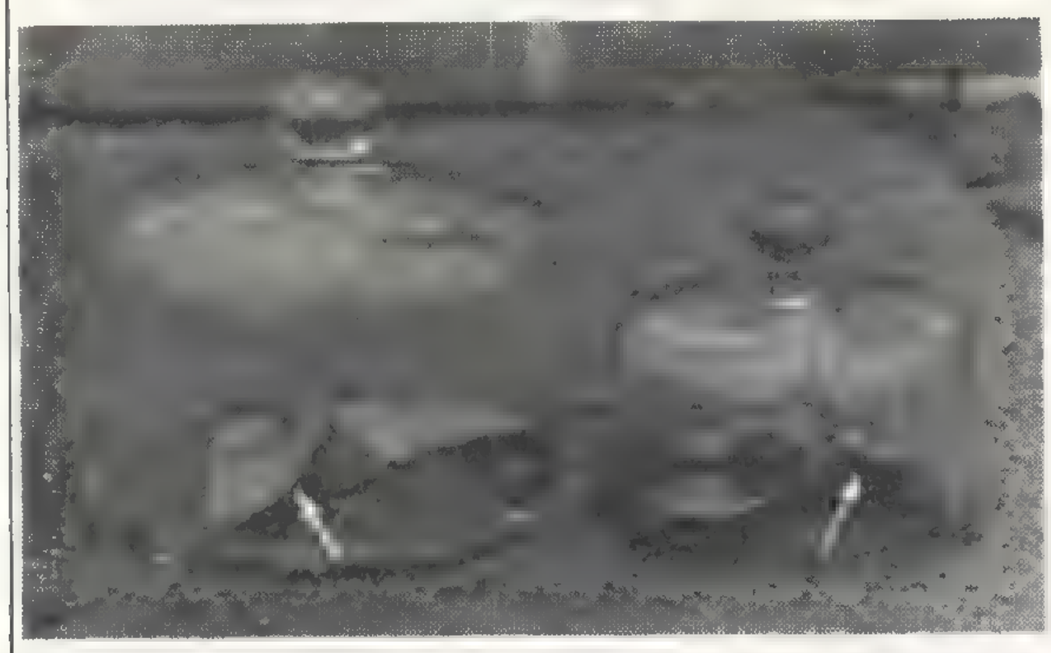
Root cuttings of tender plants do well in the greenhouse if exposed to a moderately cool temperature. The cuttings can be made at any time of the year. Some thrive better if placed in the sand vertically with the ends slightly protruding above the surface, but when in doubt use the prostrate method.

The list of plants that can be propagated by root cuttings is of course extensive. A few examples are as follows:

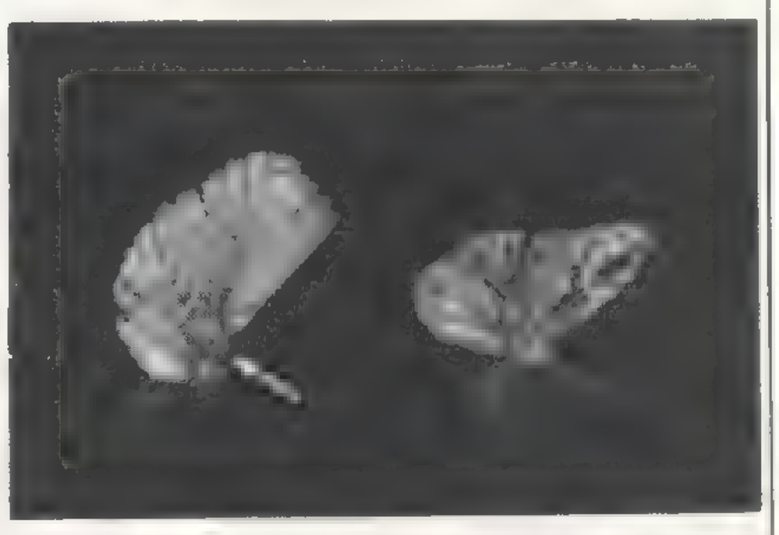
Aesculus parviflora—Dwarf Buck-eye
Ailanthus –Tree-of-heaven
Amelanchier—Shadbush
Anchusa—Bugloss
Bocconia—Plume Poppy
Bouvardia
Campsis—Trumpet Creeper
Caragana—Pea-shrub
Cirsium arvense—Canada Thistle
Chaenomeles—Flowering Quince
Crataegus—Hawthorn

1. LEAF CUTTINGS OF REX BEGONIA

2. REX BEGONIA LEAVES IN SAND

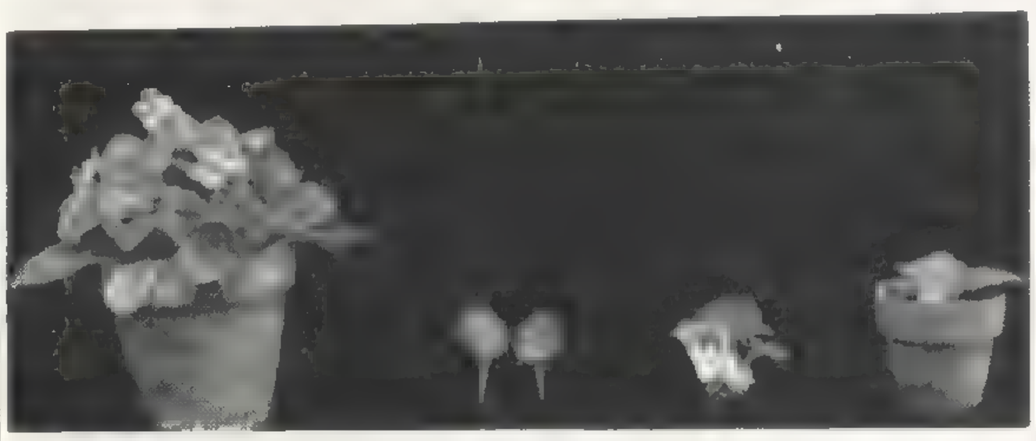


3. YOUNG PLANTS FORMING ON REX BEGONIA LEAF

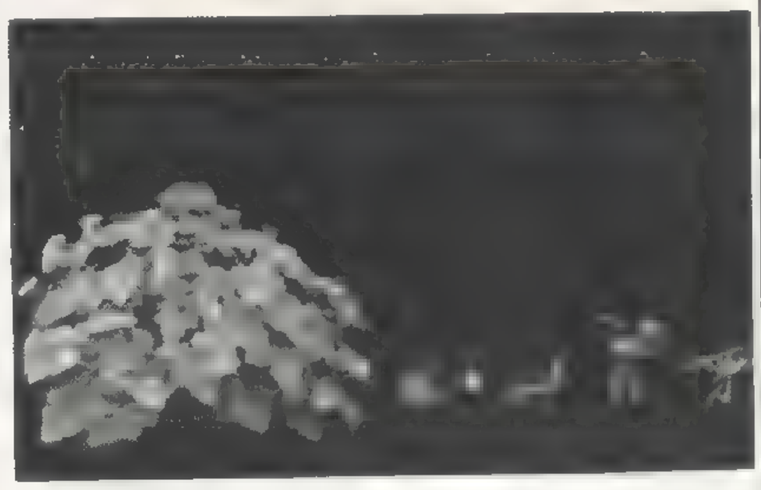


4. REX BEGONIA LEAVES ROOTED

5. OFFSETS OF ECHINOPSIS



6. LEAF CUTTINGS OF AFRICAN VIOLET



7. VIVIPAROUS LEAVES OF TOLMIEA

8. LEAF CUTTINGS OF BRYOPHYLLUM

9. LEAF-BUD CUTTINGS OF GERANIUM AND BEGONIA

Dicentra spectabilis—Bleeding-heart
Euphorbia—Spurge
Gypsophila—Baby's-breath
Halesia—Silver-bell
Paeonia—Peony
Papaver orientale—Oriental Poppy
Pelargonium—Geranium
Phlox—hardy type
Prunus—Plum, Cherry, Peach
Pyrus—Pear, Apple
Radicula Armoracia—Horseradish
Rhus—Sumac
Robinia—Locust
Rosa—Rose
Rubus—Raspberry, Blackberry
Sambucus—Elder
Staphylea—Bladder-nut
Syringa—Lilac
Taraxacum—Dandelion
Verbascum—Mullein
Wisteria
Xanthoceras
Yucca—Adam's-needle
Zanthoxylum americanum—Prickly Ash

Suckers.—Plants which produce suckers from the roots can also be readily increased by root cuttings. Willow, poplar, black locust, and sassafras propagate naturally by suckers, the shoots arising at various points along the roots (pl. 21, fig. 6). These adventitious growths can be separated from the parent and planted individually.

Tuberous roots.—The enlarged, fleshy storage roots of plants, such as the dahlia, sweet-potato, tuberous begonia, and caladium, are used for propagating purposes. Most tuberous roots (the dahlia excepted) have the ability to produce adventitious buds and form new plants. Merely plant the root in moist sand or soil and wait for developments. Sweet-potatoes sprout easily in a jar of water (pl. 21, fig. 3).

Dahlia clumps which have been stored in dry peat over winter should be divided in the spring when the buds begin to show at the base of the stem. The tuberous roots must be separated carefully in order that there be at least one bud to each division, otherwise no shoots will develop from the root when it is planted in the garden (pl. 21, figs. 1 and 2). Dahlia roots started in sand in the greenhouse about the latter part of April will form numerous shoots which can be used as cuttings.

3. PROPAGATION BY MEANS OF LEAVES

In addition to propagation by stems and roots, many plants have the ability to produce entire new individuals from leaves. This process may occur naturally as in the case of viviparous leaves, or artificially by various types of leaf cuttings.

1. LEAF CUTTINGS OF SANSEVIERIA

2. GASTERIA LEAF CUTTING

3. VIVIPAROUS LEAVES OF BRYOPHYLLUM

4. DIVISION OF VARIEGATED SANSEVIERIA

5. OFFSETS OF ANTHERICUM

Viviparous leaves.—Certain kinds of water-ferns, water-lilies, bryophyllums, and *Tolmiea Menziesii* develop young plants naturally on their leaves (pl. 22, fig. 7, and pl. 23, fig. 3). In due time the young plants will detach themselves from the parent leaf and fall to the ground or float away on the water to establish an independent plant. Thus a large plant may become surrounded with a host of offspring like a mother hen with a brood of chicks. In the garden and greenhouse, man usually assists nature by removing the plantlets and potting them up in soil.

Cuttings.—Plants with thick fleshy leaves and petioles (leaf stems) containing sufficient reserve food can generally be propagated by some form of leaf cutting. An *entire* leaf of bryophyllum placed right side up on moist sand will quickly form a small plantlet at most every notch on the leaf (pl. 22, fig. 8). A leaf of Rex begonia treated likewise will send forth a number of sprouts from the base of the leaf where all the veins intersect and also from the end of the petiole. Another method is to *sever the veins* of the Rex begonia leaf in various places. When such a leaf is placed in close contact with moist sand and bottom-heat applied, a new plant should arise from each wound (pl. 22, figs. 1-3). Rex begonias are also reproduced by cutting the leaves into *sections,* each section retaining a portion of the fleshy base of the leaf. If these pieces are placed upright in the sand, new shoots and roots will soon appear (pl. 22, fig. 4). The confined atmosphere of a Wardian case or a bell-jar and slight bottom-heat are essential for success with all leaf cuttings of Rex begonias.

Succulent plants, such as Kalanchoë, Byrnesia, Echeveria, and Oliveranthus, are very easily propagated from leaf cuttings. The fleshy leaves are carefully detached from the parent plant and placed on moist sand. Only the base of the leaf should be covered with sand, the rest of the leaf remaining exposed to the light. The young plant originates from the latent bud at the base of the leaf (pl. 24, fig. 2). When taking the leaves from the parent plant be careful not to wound them, as they are very subject to rot. Avoid excess moisture. These plants are adapted to rather dry conditions, and to keep the sand saturated with water is to invite trouble.

1. DIVISION OF ORCHID PLANT

2. OFFSETS AND LEAF CUTTINGS OF ECHEVERIA

3. CYPERUS PROPAGATED FROM HEAD OF LEAVES

The leaves of some plants must have the *petioles attached* in order to strike root (pl. 22, fig. 6). The cuttings are placed vertically in the sand with the petioles buried one or two inches. Young shoots and roots develop from the callus formed on the ends of the petioles. Plants propagated by this method are:

Begonia semperflorens—Ever-blooming Begonia
Gesneria
Ginkgo—Maidenhair Tree
Gloxinia
Hoya—Wax Plant
Peperomia
Saintpaulia—African Violet
Streptocarpus—Cape Primrose

With *Cyperus alternifolius* (umbrella plant) an entirely different type of propagation is necessary. The stem is cut off a few inches below the head of leaves which is pruned to a convenient length. The cutting is then placed in the sand deep enough to cover the entire head, leaving only the tips of the leaves exposed. Roots and shoots arise from the buds in the axils of the leaves, not from the stem as with most cuttings (pl. 24, fig. 3). When potting up the young plant, remove the old original leaves.

Another odd type of leaf cutting is that used for propagating Sansevieria (bowstring hemp). The long leathery leaves are cut into pieces several inches in length and the basal ends inserted vertically in the sand, leaving about one-half of the cutting exposed. Roots and shoots develop from adventitious buds formed at the base of the cutting (pl. 23, fig. 1). Avoid excess moisture with these succulent plants. Strangely enough, the yellow variegations of *S. trifasciata* var. *Laurentii* are not transmitted through leaf cuttings. To preserve these variegations the plant must be increased by division of the clump (pl. 23, fig. 4).

A *leaf-bud* cutting includes the leaf, the petiole, the bud in the axil of the leaf, and a portion of the main stem (pl. 22, fig. 9). Roots develop from the "heel" and shoots from the axillary bud. Geraniums, *Begonia semperflorens*, Acalypha, and Chrysanthemum are easily reproduced in this manner. It is a good way to get a large increase from a limited amount of stock.

4. PROPAGATION BY DIVISION

Plants which form a series of stems from a large crown or those which spread readily by suckers and offsets, making large clumps, are effectively propagated by division (pl. 14, fig. 3, and pl. 24,

fig. 1). The old plant is dug up or knocked out of the pot and separated into small sections, each having roots and shoots. Plants that make a rampant growth are usually divided every year to keep them in bounds and to avoid crowding. This is especially true with vigorous plants in small rock gardens and flower borders. The following plants need frequent division:

Achillea—Yarrow
Artemisia vulgaris—Mugwort
Aster—hardy types
Boltonia
Campanula—Bellflower
Centaurea Cyanus—Cornflower
Cerastium tomentosum—Snow-in-summer
Ceratostigma plumbaginoides—Blue Leadwort
Chrysanthemum—hardy types
Dianthus—Pink
Doronicum—Leopards-bane
Euphorbia—Spurge
Helianthus—Sunflower
Oenothera—Evening Primrose
Penstemon—Beard-tongue
Phlox—hardy types
Ranunculus—Buttercup
Sedum—Stonecrop
Solidago—Goldenrod
Thalictrum—Meadow-rue
Veronica—Speedwell

Division and replanting of most garden material is usually done in early fall so that normal growth proceeds uninterrupted in spring. The following perennials are rather slow growing and are generally divided every three or four years:

Alyssum saxatile—Golden-tuft
Aquilegia—Columbine
Astilbe
Delphinium—Larkspur
Dicentra spectabilis—Bleeding-heart
Echinacea—Coneflower
Hemerocallis—Day-lily
Hosta—Plantain-lily
Iris
Liatris—Blazing Star
Linum—Flax
Phlox

Peonies should be divided about every seven years. Greenhouse plants, such as ferns, orchids, asparagus, violets, etc., are readily increased by division. Shrubs that have a tendency to spread can also be separated when necessary. This is best done in late fall when the plants are dormant.

Of course to appreciate how fascinating plant propagation really is, one has to bolster up a discussion of this sort with practical demonstrations. After these proposed methods have all been tried, there is still another very important subject to consider, namely, grafting, which is one of the most intriguing arts of gardening. And now it has been discovered that certain chemicals applied to the aerial parts of growing plants cause various kinds of abnormal growth responses, including the rapid formation of

roots wherever the magic chemicals contact the stems or leaves. Will these strange growth-producing substances antiquate the present methods of plant propagation? We all have so much to learn that a closed mouth and an open mind are cardinal virtues in this day of scientific endeavor. D. C. F.

NOTES

Mr. A. P. Beilmann, Arboriculturist to the Garden, spoke before the St. Louis Horticultural Society, March 6, on "The Fertilization of Trees."

Recent visitors to the Garden include Dr. Delzie Demaree, of the University of Oklahoma; and Dr. J. A. Drushel, Professor of Education, New York University, N. Y.

Dr. Edgar Anderson, Geneticist to the Garden, gave a talk before the St. Louis Unit of the Women's Overseas Service League, at the Town Club, February 19, on "Plant Hunting in the Balkans."

Dr. David C. Fairburn, Research Assistant to the Garden, addressed the civics group of the St. Louis College Club, February 25, on "Landscaping the Home Grounds."

Mr. L. P. Jensen, Manager Missouri Botanical Garden Arboretum, gave a talk before the Parent-Teachers' Association of Gray Summit, February 11, on "The Henry Shaw Gardenway."

Mr. Ladislaus Cutak, in charge of Succulents at the Garden, gave an illustrated lecture on "Vagabonding in the Southwest" before the St. Louis Wild Flower Club, March 3; and before the Webster Groves Nature Society at Webster Groves, Mo., March 6.

Number 1 of Volume XXIII of the ANNALS OF THE MISSOURI BOTANICAL GARDEN was issued in March. The contents are as follows: "A Comparative Study of Conidial Formation in *Cephalosporium* and Some Related Hyphomycetes," M. Elizabeth Pinkerton; "A Study of the Genus *Helicogloea*," Gladys E. Baker; "Morphology, Physiology and Cytology of *Syringospora inexorabilis (Monilia inexorabilis)*," Carroll W. Dodge and Morris Moore.

Dr. Edgar Anderson, Geneticist to the Garden, is one of the authors of a paper in the February number of *House Beautiful*

(**78:** 89) entitled "Are Flower Shows Really Helpful?"; with Dr. W. B. Turrill as co-author, he has a paper in *Nature* (**136:** 986. 1935) on "Biometric Studies on Herbarium Material." His paper on "Oriental Crab-apples" in the December, 1935, *Bulletin of the Arnold Arboretum* has been reprinted in the February number of the *Garden Digest* (**8:** 18-20).

STATISTICAL INFORMATION FOR FEBRUARY, 1936

GARDEN ATTENDANCE:	
Total number of visitors	5,969
LIBRARY ACCESSIONS:	
Total number of books and pamphlets bought	58
Total number of books and pamphlets donated	240
PLANT ACCESSIONS:	
Total number of plants and seed packets donated	1,001
HERBARIUM ACCESSIONS:	
By Purchase—	
Degener, Otto—Plants of Hawaii	105
Natural History Museum, Botanical Division, Stockholm—Plants of Brazil, collected by P. Dusén	240
By Gift—	
Anderson, E.—*Weisia viridula* (L.) Hedw. from Missouri	1
Anderson, E.—Plant descriptions and illustrations	7
Collom, Mrs. W. B.—*Funastrum* from Arizona	1
Drushel, J. A.—*Silphium* sp. from Texas	1
Eastman, Robert E.—*Bryophyllum* sp. from horticulture	1
Harrison, Bertrand—Plants of Utah	223
Lewis, Bro. Hubert—Plants of Missouri	40
Martz, E.—*Brassavola* sp. from Colombia, South America	1
Przemecky, Ing.—Plants of Roumania	18
Williams, L. O.—Plants of central and western United States	13
By Exchange—	
Botanical Museum, University of Cluj—Plants of Roumania	313
Demaree, Delzie—Plants of Ohio, etc.	217
Hermann, F. J.—Plants of Michigan	137
Keck, David—Plants of western United States	93
Natural History Museum, Botanical Division, Stockholm—Plants of Scandinavia	54
Natural History Museum, Botanical Division, Stockholm—South American lichens	102
Purer, Miss Edith A.—Plants of California	124
University of California at Los Angeles by C. C. Epling—Plants of California	172
By Transfer—	
Moore, George T.—*Trichilia* sp. from horticulture	1
Total	1,864

SOME FACTS ABOUT THE GARDEN

The Missouri Botanical Garden was opened to the public by Mr. Henry Shaw about 1860. From that date to the death of Mr. Shaw, in 1889, the Garden was maintained under the personal direction of its founder, and while virtually a private garden it was, except at certain stated times, always open to the public. Although popularly known as "Shaw's Garden" the name Missouri Botanical Garden was designated by Mr. Shaw as its official title and in his will or in any of his writings he specifically referred to it as the "Missouri Botanical Garden." By a provision of Mr. Shaw's will the Garden passed at his death into the hands of a Board of Trustees. The original members of the Board were designated in the will, and the Board so constituted, exclusive of certain ex-officio members, is self-perpetuating. By a further provision of the will, the immediate direction of the Garden is vested in a Director, appointed by the Board of Trustees. The Garden receives no income from city or state, but is supported entirely from funds left by the founder.

The city Garden comprises 75 acres, where about 12,000 species of plants are growing. There is now in process of development a tract of land of over 1,600 acres outside the city limits which is to be devoted to (1) the propagation and growing of plants, trees, and shrubs, designed for showing either indoors or outside, at the city Garden, thus avoiding the existing difficulties of growing plants in the city atmosphere; (2) gradually establishing an arboretum as well as holding a certain area as a forest reservation, with the idea that possibly at some future time this may become the new botanical garden.

The Garden is open to the public every day in the year, except New Year's Day and Christmas—week days from 8:00 a. m. until sunset; Sundays from 10:00 a. m. until sunset.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Place, on the Sarah car line (No. 42). Transfer south from all intersecting lines.

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MISSOURI BOTANICAL GARDEN BULLETIN

Vol. XXIV APRIL, 1936 No. 4

CONTENTS

	Page
Feeding the Shade Trees	95
A Six-Weeks' Course in Field Botany, June 16 to July 24, 1936	114
Notes	115
Statistical Information	116

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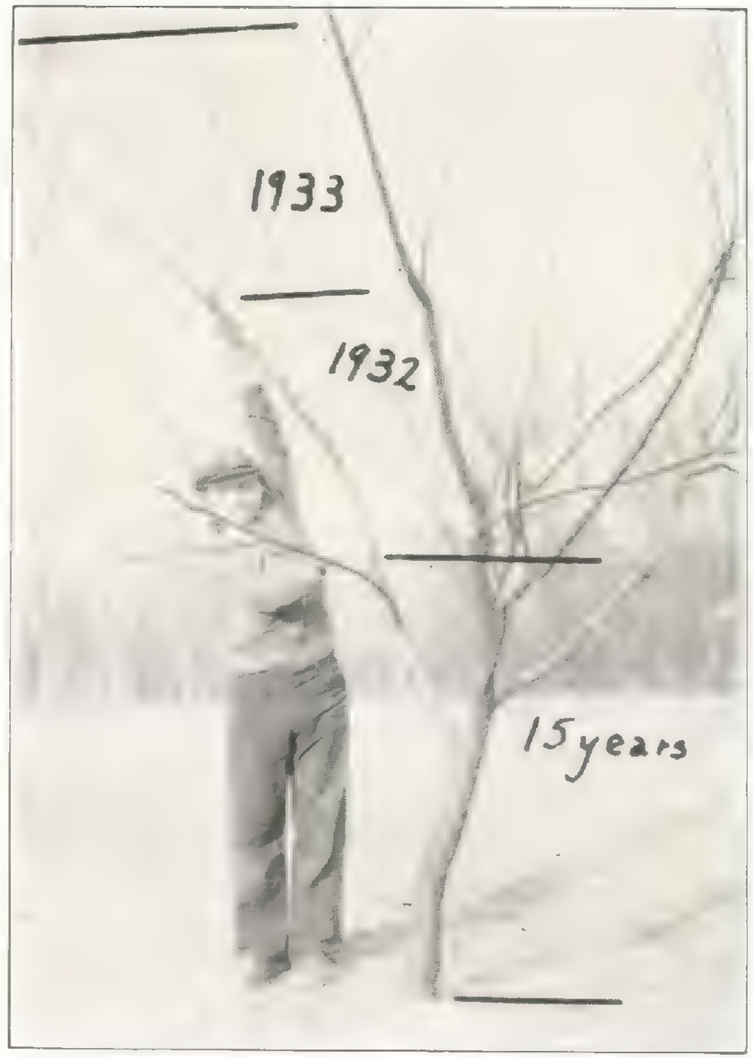
1

CROSS SECTION OF 57-YEAR OLD-PINE TRUNK, SHOWING DECREASE IN ANNUAL GROWTH, RESULTING IN DEATH. BLACK LINE MARKS SIZE WHEN 28 YEARS OLD.



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GROWTH OF BLACK WALNUT DURING TWO DRY SEASONS.

Missouri Botanical Garden Bulletin

Vol. XXIV APRIL, 1936 No. 4

FEEDING THE SHADE TREES

Gardening publications have generally evaded references to tree feeding. Sometimes the subject was unavoidable, in which case it was covered in one short paragraph, leaving the critical reader to answer his own questions. Many writers failed to realize the necessity of feeding shade trees. Others called attention to it, but neglected to give directions. More recently definite instructions are sometimes given, since it is now understood that starvation is the most common cause of death in mature shade trees.

Two numbers of the Garden Bulletin have dealt with the problem of supplying shade trees with food. The first article, in October, 1929, "The Feeding of Shade and Ornamental Trees," brought together the meagre information then available. The second, "How to Feed a Shade Tree," appeared in April, 1934, and recounted the five years of experimental work which began before the publication of the first bulletin. The present article becomes necessary, since both the earlier bulletins are out of print. It now incorporates the results of six years of work, and was presented in essentially the same form before the Tenth National Shade Tree Conference, August, 1934. Later the paper was rewritten for *The Shade Tree* (Bulletin of the New Jersey Federation of Shade Tree Commissions). Through the courtesy of the Garden it has also been republished in a number of gardening periodicals.

SYMPTOMS OF STARVATION

The first symptom is a decrease in the growth at the tips of the branches (annual terminal growth) and in the width of the trunk

(diameter increment). In the early stages, especially with large trees, the reduced growth is difficult to detect. In most shade trees, except the dwarf varieties, a terminal growth of 4 inches annually should be considered the minimum. An annual increase in length of 8 inches or more might be termed normal, while 12 inches or more indicates a tree not in need of food. Below the minimum growth rate starvation symptoms become marked. Coincident with the diminished growth there is a rapid decrease in the size of the leaf combined with a loss of the dark green color, in serious cases the venation only remaining green. While a careful diagnosis is particularly important, shade trees generally are so dangerously under-fed that it is better to feed first and diagnose later. This does not mean, however, that the presence of insect pests or diseases can be overlooked, or that feeding is a cure-all. It is well known that the under-nourished tree most generally falls prey to the ever-present enemies. The declining tree cannot resist borer attacks; nor can it withstand dry weather; nor can it sacrifice any more of its few yellow leaves during a caterpillar invasion. A well-fed tree will require much less water than its starving neighbors. To the tree owner in the Middle-West, this last feature, always associated with feeding, is worth the expense involved and cannot be over-emphasized.

The death of an Austrian pine at the Garden in 1932 furnished an unusual opportunity to study the effect of starvation on the growth rate. By means of a post-mortem examination, in which the entire tree was sectioned longitudinally, the exact increase in height (fig. 1) and diameter (pl. 25, fig. 1) for each year was determined. Starvation caused a remarkable stunting in height as well as diameter. During the first nineteen years of its life it grew 31 feet, 8 inches, this being 83 per cent of its mature height. The remaining thirty-eight years contributed only a meagre 6 feet, 5 inches. The same ratio existed between the early and late diameter increase. This pine, planted in 1873, was almost as large in 1892 as it was thirty-eight years later. The effect of a diminishing food supply is clearly evident in this case. Any declining shade tree, upon post-mortem examination, would show precisely the same history. However, deciduous trees, being far less tenacious, collapse in a much shorter time. The annual

butchering of lawn trees or the lopping of street trees simply hastens the process. The chief difference lies in the ultimate height attained.

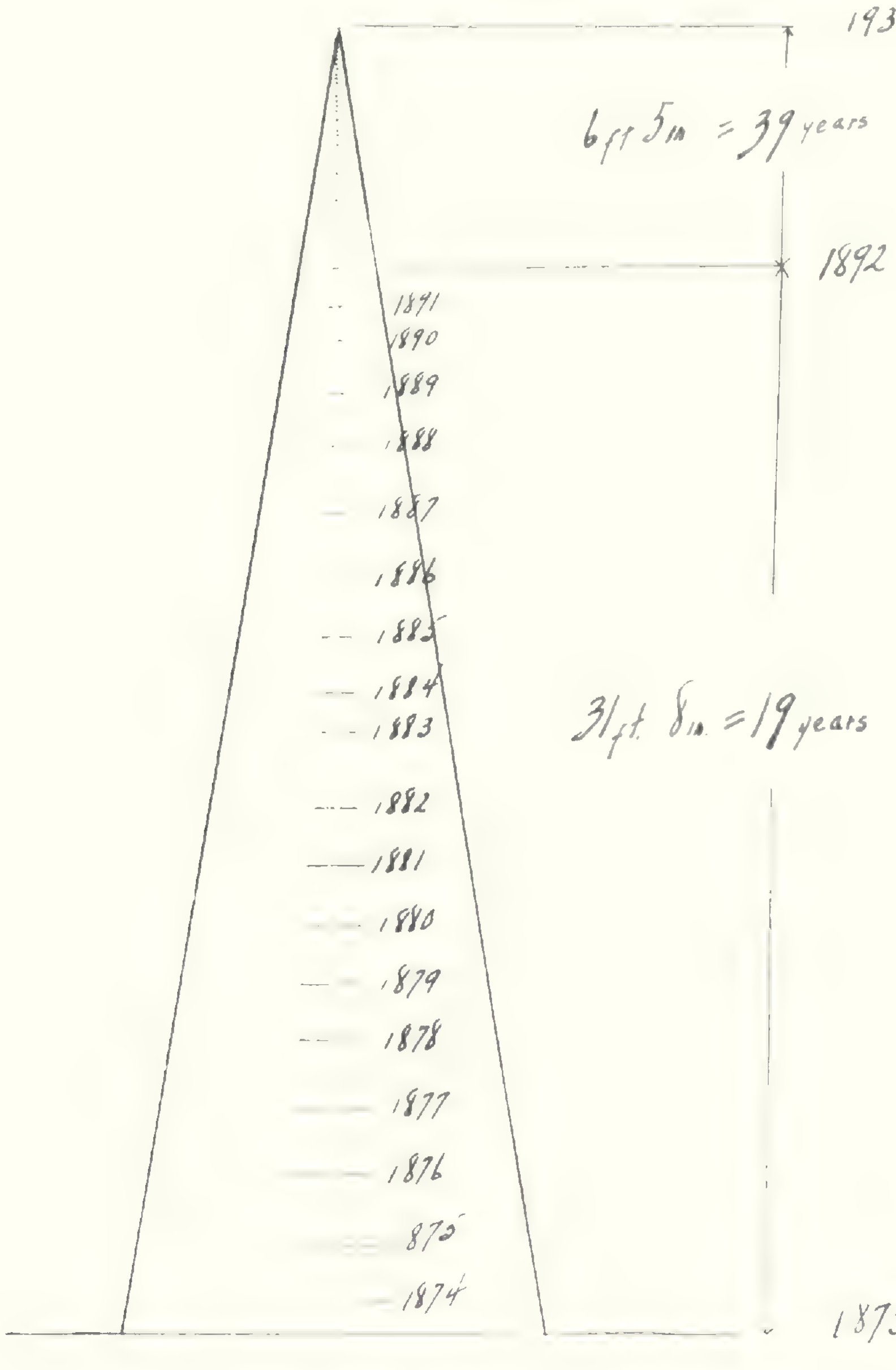


Fig. 1. Annual height increase of *Pinus austriaca*.

SOIL DEFICIENCIES CAUSING STARVATION

Experimental work has shown that the shortage of any one of three elements may be responsible for the reduced growth rate of shade trees. These three elements are: nitrogen, phosphorus, and potash. Fortunately, they are all supplied through the soil. There are other elements needed for tree growth, but in such small amounts that their absence rarely causes any damage. The one exception is iron, a deficiency of which causes chlorosis of oaks and sweet-gums.

It was necessary, first of all, to determine the importance of these three elements and to discover in what ratio they were needed by the tree. Thus, the first year was devoted to the feeding of these elements, singly and in combinations. Later, complete fertilizers, from which either nitrogen, phosphorus, or potash had been omitted, were used. The knowledge thus gained governed the formula used on certain trees the next year. In this way, each year, some trees served as living laboratories in which complete fertilizers were assimilated, while others were fed various amounts of the incomplete fertilizers. It soon became evident that nitrogen was, in nearly all cases, the limiting factor in tree growth. However, an application of nitrogen alone was not so effective as a combination of nitrogen and phosphorus. Potash, when fed alone, caused no change in the growth rate, but its presence was necessary to obtain the maximum stimulus from combinations of the other two materials.

EVOLUTION OF THE PRESENT FORMULA

Since the complete fertilizer formula had to be adjusted each year to agree with the experimental findings, a continual change was inevitable. The following typical record of a single tree shows the trend:

1929	5 pounds	4-8-4
1930	10 pounds	8-6-4
1931	12 pounds	8-8-4
1932	25 pounds	8-8-4
1933	25 pounds	10-8-6

This tree belonged to the group being fed the amount and kind of fertilizer which had proved most effective for the experimental trees during the preceding year. The most conspicuous feature of

this record is the five-fold increase in dosage and the more than doubling of the nitrogen content. This means that all trees were being fed ten times more nitrogen in 1933 and thereafter than in 1929. In all cases the growth rate has shown a very close relationship to the amount of food given and especially to the percentage of nitrogen it contained. The following record of a pin oak shows this clearly:

Date	Formula	Amount	Increase in trunk diameter
1928	8-4-6	3 pounds	.10 inches
1929	4-8-4	4 pounds	.10 inches
1930	4-8-4	5 pounds	.45 inches
1931	8-8-4	10 pounds	1.05 inches
1932	8-8-4	25 pounds	1.20 inches
1933	10-8-6	25 pounds	1.35 inches

During the first three years the application of small quantities of food low in nitrogen made no appreciable change in the growth rate. After 1931 larger amounts of fertilizer containing more nitrogen caused the growth rate to increase to more than twice that of a normal tree. At the present time a 10-8-6 formula is being used. It will not be changed until future experimental work shows the need.

MIXING A COMPLETE FERTILIZER

The three materials required for shade-tree food may be purchased separately and mixed, or they may be obtained mixed and ready for use. In purchasing fertilizers it is necessary that the analysis be known. This is usually printed on the sack, and is expressed as "per cent available." Only by an analysis can the potential value of a fertilizer for shade-tree food be judged. It is equally important that the material from which it is made be known, since this affects its solubility and therefore its value. The cost per bag is a poor criterion in selecting fertilizers. Nitrogen may be obtained as nitrate of soda or ammonium sulphate. Both have about the same analysis, testing "20 per cent available nitrogen." Phosphorus is supplied as super-phosphate, analyzing "20 per cent available phosphoric acid." Potash is commonly furnished as muriate of potash, generally "50 per cent available potash." The above four materials are not the only sources of plant food suitable for mixing as complete fertilizers, but they

are the most easily obtained. To make 200 pounds of a 10-8-6 tree food, the indicated amounts of each of the following are needed:

Ammonium sulphate or	
Nitrate of soda	100 pounds
Super-phosphate	76 pounds
Muriate of potash	24 pounds
Total	200 pounds

Nearly half of the plant food in the above formula is nitrogen. Actually 10 pounds of each 24 pounds of available plant food is nitrogen, or 41.6 per cent of the total. The experimental work carried on at the Garden has shown that the greatest stimulus follows the use of a fertilizer having this ratio of nitrogen to phosphorus and potash. The materials used have all been quickly available. No evidence has appeared to show that slow-acting fertilizers were of any particular value. A starving tree needs food immediately, not at some future date.

TIME OF APPLICATION AND PERIOD OF EFFECTIVENESS

Early spring is the most satisfactory time to feed trees, since most of the annual growth takes place in the ten-week period between April 15 and June 10. However, there is no objection to the use of fertilizers during any other part of the year, summer or winter. There seems to be little danger from fall applications producing succulent growth too late to ripen before frost. Fertilizers control the rate of growth as well as the total growth, but have no influence upon the periodicity of growth.

Slow-acting fertilizers, often of an organic nature, have been added to tree foods in the hope that the period of effectiveness might be lengthened. Immediately-soluble materials have been likened to a hypodermic injection—quick to stimulate and equally quick in wearing off. In order to test this theory a group of seven oaks was used. These trees were fed such large amounts of 10-8-6 in the spring of 1930 that the average terminal growth of the group was 32 inches. The maximum was attained by a pin oak which grew 37 inches. After five years the effects of this one feeding were still evident, the terminal growth of the group averaging 11 inches, while the maximum is 18 inches. From this

and similar tests, it becomes evident that quickly available fertilizers are not just temporary measures. They prove to be a stimulus for at least five years.

SELECTION OF FORMULAS AND DOSAGES

In the choice of both formula and dosage, all emphasis has been placed on obtaining a characteristic response which could not be masked or otherwise absorbed by either seasonal fluctuations or any other variable affecting tree growth. The rule has been that the response must be definitely due to feeding and clearly not to any environmental influences. At first, check trees were used to measure growth changes. This was discontinued in the second year, when it was found that the variation in growth rate between trees, seemingly alike, was greater than the seasonal variation of an individual tree. The seasonal fluctuation, for a time, became a very important factor, and was encountered whenever accurate tabulations of growth responses were required. Later, when it became evident that trees needed large quantities of fertilizer, it ceased to be important. Since then, all growth changes following fertilization have been checked against the previous growth rate of that same tree. In this connection, it might be pointed out that the response to small quantities of fertilizer has never been great enough to measure. Sometimes the leaves became a shade darker and perhaps were retained longer than normally, but such slight changes cannot be tabulated. For instance, a tree which has been adding $\frac{1}{8}$ inch annually to its diameter will not be greatly assisted in its struggle by feeding it just enough to darken the leaves. In these experiments all efforts have been directed toward developing a formula and particularly a dosage table, the use of which would cause a starving tree to respond by producing a luxuriant growth shortly after the application.

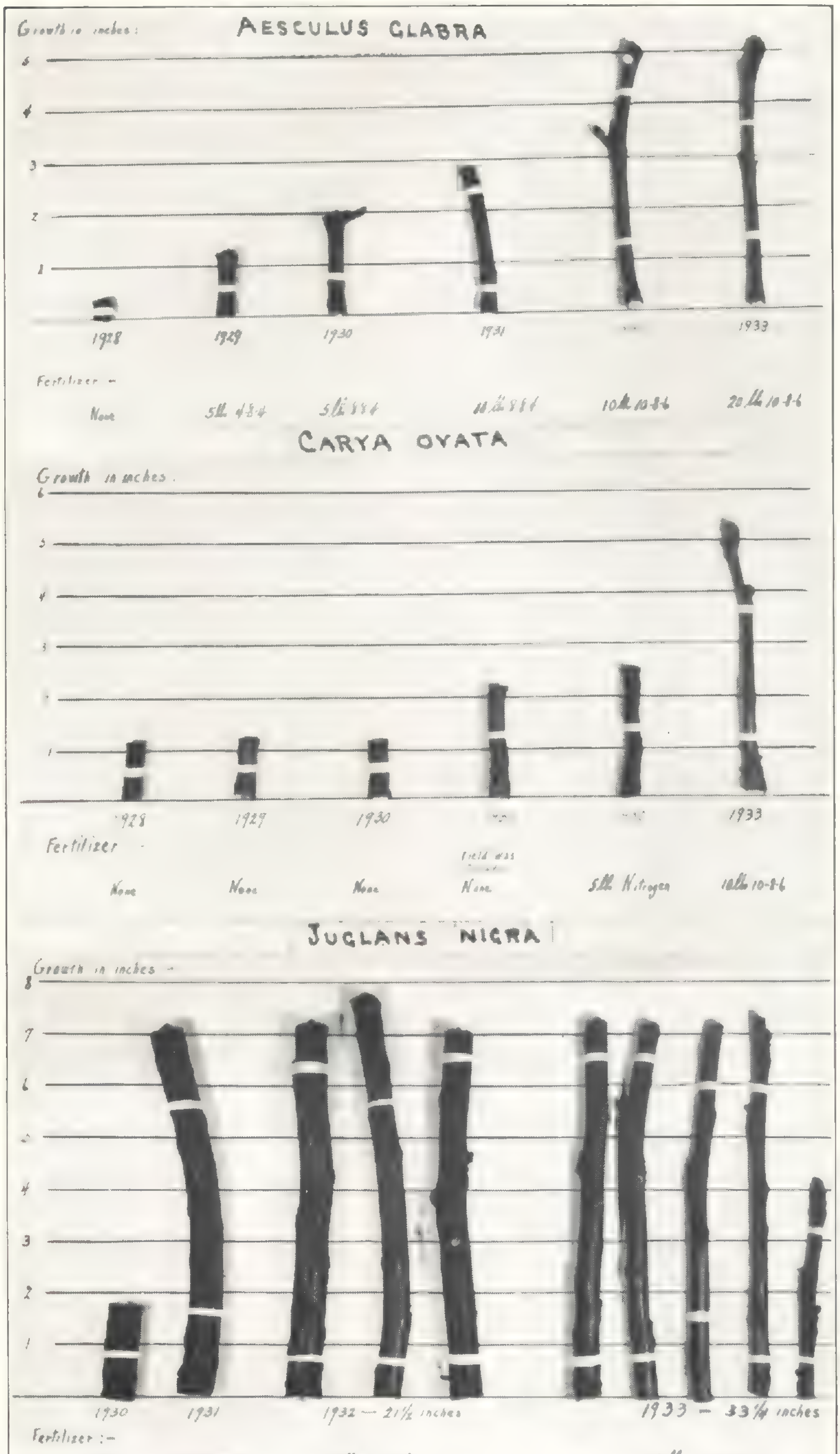
THE VALUE OF A CHEMICAL ANALYSIS IN CHOOSING FERTILIZERS

The "blanket application" of a complete fertilizer has been strongly condemned by Mitchell (Black Rock Forest Papers, 1934). He has found "a close association between soil phosphorus supply and the quantity of this element in red oak leaves," and has developed a method of determining the tree's require-

ments on a basis of an analysis of the leaves. In defense of the "shot-gun" method it might be pointed out that at the present time the owner of a few trees could not obtain such an analysis. Even if this service were available the cost would be greater than the total expense of feeding. In commercial practice, much of the work is done during the dormant season when no leaves are present. Mitchell further states that "it is not possible to prepare a single fertilizer, regardless of the empirical formula upon which it is based, that will be specifically applicable to any and all soil conditions." This was recognized long ago in the experimental work in the Garden. To the above might be added that not only should the formula change with different soil conditions, but it should also vary with each species of tree. This rule will be further complicated by the wide distribution of some tree species, as well as by meteorological conditions and the topography of the individual habitat. At the present time nothing is known of the requirements of each species, and much less concerning the demands of the same species when grown in central New York, or when found in the southeastern Missouri lowlands. Since trees unfold leaf buds in one season, produce flowers in another, mature seed and finally shed leaves at other periods, it is not inconceivable that the formula should fit the activity. Therefore, until all the above information is forthcoming, the "shot-gun" method will continue in use. It does produce results.

RESULTS FOLLOWING APPLICATION OF FERTILIZERS

To illustrate the increased growth following feeding, typical branches were taken from three trees. These were sectioned (pl. 26, figs. 1-3) to show the annual increase in length for six years. The first is from a buckeye *(Aesculus glabra)* which grew less than ½ inch in 1928. Fertilizing was started the following year with five pounds of 4-8-4 and gradually increased each year. The first nearly normal growth made by this tree for many years occurred in 1932 when it grew 5 inches. A hickory *(Carya ovata)* had attained a height of 7 feet and a trunk diameter of 2½ inches in twenty-eight years. It was very near death from starvation, as was shown by its response to feeding. The black walnut *(Juglans nigra)* was fifteen years old and 3 feet high in 1930, when the first



BRANCHES OF TREES SHOWING ANNUAL GROWTH OF UNDER FED TREES, AND EFFECT OF FERTILIZER. TOP—BUCKEYE *(AESCULUS GLABRA)*; CENTER—HICKORY *(CARYA OVATA)*; BOTTOM—BLACK WALNUT *(JUGLANS NIGRA)*.

1

POST-HOLE METHOD. LEAF MOLD, PEAT, OR MANURE PLUS FERTILIZERS USED TO FILL HOLE.

2

HOLE 16 18 INCHES DEEP, MADE WITH PUNCH-BAR.

efforts to feed it were started. The application of five pounds of nitrate of soda in 1931 caused it to grow 7 inches in height that year. In the two years following it was included in a group of trees which were to be fed "toxic" doses of fertilizer. As a result of the heavy applications it grew 21½ inches in 1932, and 33¼ in 1933—both very dry years.

For several years attempts were made to feed trees such large quantities of fertilizer that injury would result. Some small trees have been given one-half their calculated dry weight of 10-8-6 and 15-30-15 mixtures. This meant using as much as 25 pounds for trees 3 inches in diameter. These large amounts were very enthusiastically accepted. One tree grew 42 inches higher that summer; another produced shoots 11 feet long and made a total branch growth of 69 feet. The latter is the only example of "overfeeding" experienced in the Garden. The growth became so abnormally large and soft that it was unable to support itself; but, only the tips were injured the following winter.

A METHOD OF CALCULATING DOSAGES

Of far greater importance than a fertilizer formula is a knowledge of the quantity to use. Trees seem to be somewhat selective in the use of food. They reject whatever is not needed. It may be said that they assimilate only as much nitrogen as is needed to elaborate properly the available phosphorus and potash; and only as much of these as is needed for the available nitrogen. It appears therefore that some slight changes in the formula are not so important as the application of the correct amount. Dosages have been variously estimated at one pound per foot height to certain amounts per inch diameter. No single measurement can be depended upon to furnish an accurate estimate of the volume or size of a tree. For this reason many efforts to fertilize have not been successful. The spire-like Lombardy poplar will actually be much smaller in size than a field elm although both are alike in height. To discover a measurement upon which to base dosages, the dimensions of 273 trees growing in various situations were taken. A transit was used to determine the height, and a steel tape to measure the spread of the branches and the circumference of the trunk. A certain relationship was found to exist between these

figures, and this might be termed a measurement of volume or size. For the past three years the amount of fertilizer given to trees at the Garden has been based upon the following calculation: to the height (in feet) add the branch spread (in feet), and to this add the trunk circumference (in inches). The result will be the number of pounds of 10-8-6 food required for that tree. For in-

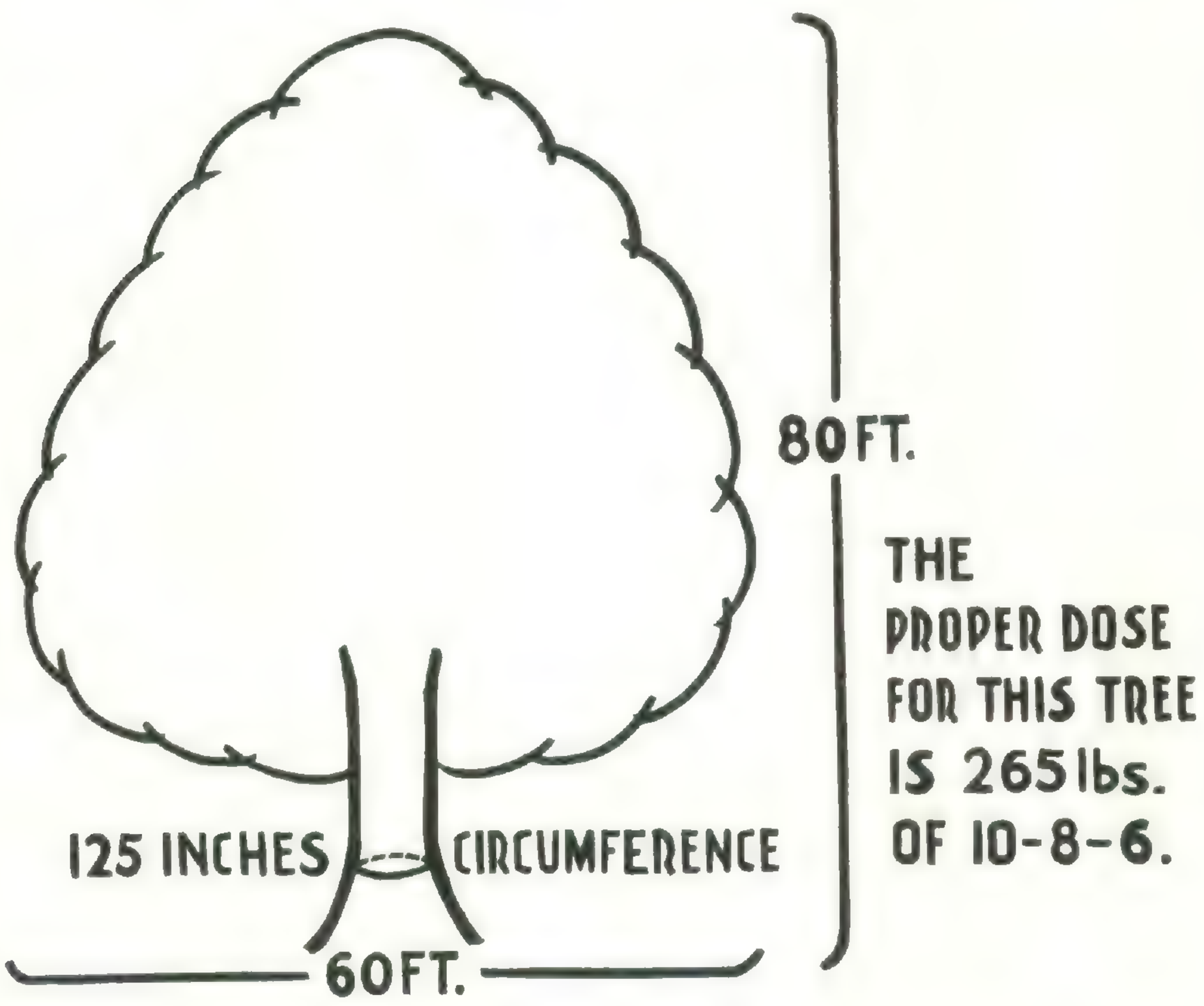


Fig. 2. How fertilizer dosage is calculated: To the height in feet (80), add the branch spread in feet (60) and the trunk circumference in inches (125). The sum is the amount of 10-8-6 fertilizer needed.

stance, a tree 80 feet high, having a branch spread of 60 feet and a trunk circumference of 125 inches, will require 265 pounds of 10-8-6 fertilizer (fig. 2). This may be reduced for trees not seriously under-nourished. It may also be reduced for some types of trees (fig. 3). The specimen growing in the open requires the full amount; the street or lawn tree having a higher crown needs

two-thirds of that amount; while the dense forest type will receive sufficient if given one-half.

REGION OF APPLICATION AND METHODS IN USE

To be effective, fertilizer should be placed near the feeding roots, which are commonly found at the tips of the larger roots. For feeding purposes the root spread may be considered as equal

Dense forest type. Use ½ of calculated dose.

Open forest, street, or lawn type. Use 2/3 of calculated dose.

Specimen type. Use full amount.

Fig. 3.

to the branch spread. The fertilizer should therefore be placed under the branch tips.

Five methods of applying food have been in use: (1) trenching, (2) post-hole, (3) punch-bar, (4) broadcast and spading, (5) injection, using either water or air pressure.

The trench method was used with an organic material and is satisfactory if the tree is in no immediate danger. An adaptation of this method is the use of a post-hole digger to make holes at irregular intervals, permitting the use of both organic and commercial fertilizer. Both of the above methods leave a lawn unsightly. The punch-bar has been used chiefly with commercial

fertilizers. Under certain conditions it has given excellent results, but becomes exceedingly laborious in hard, dry soil. One disadvantage is that in wet ground the soil in the region of the hole becomes compacted and prevents diffusion. At some later date, freezing and thawing will again restore the physical condition. Broadcasting the fertilizer on the soil and spading it under has much to recommend it if done properly, for spading has proved beneficial. The turning under of a four-inch layer of stable

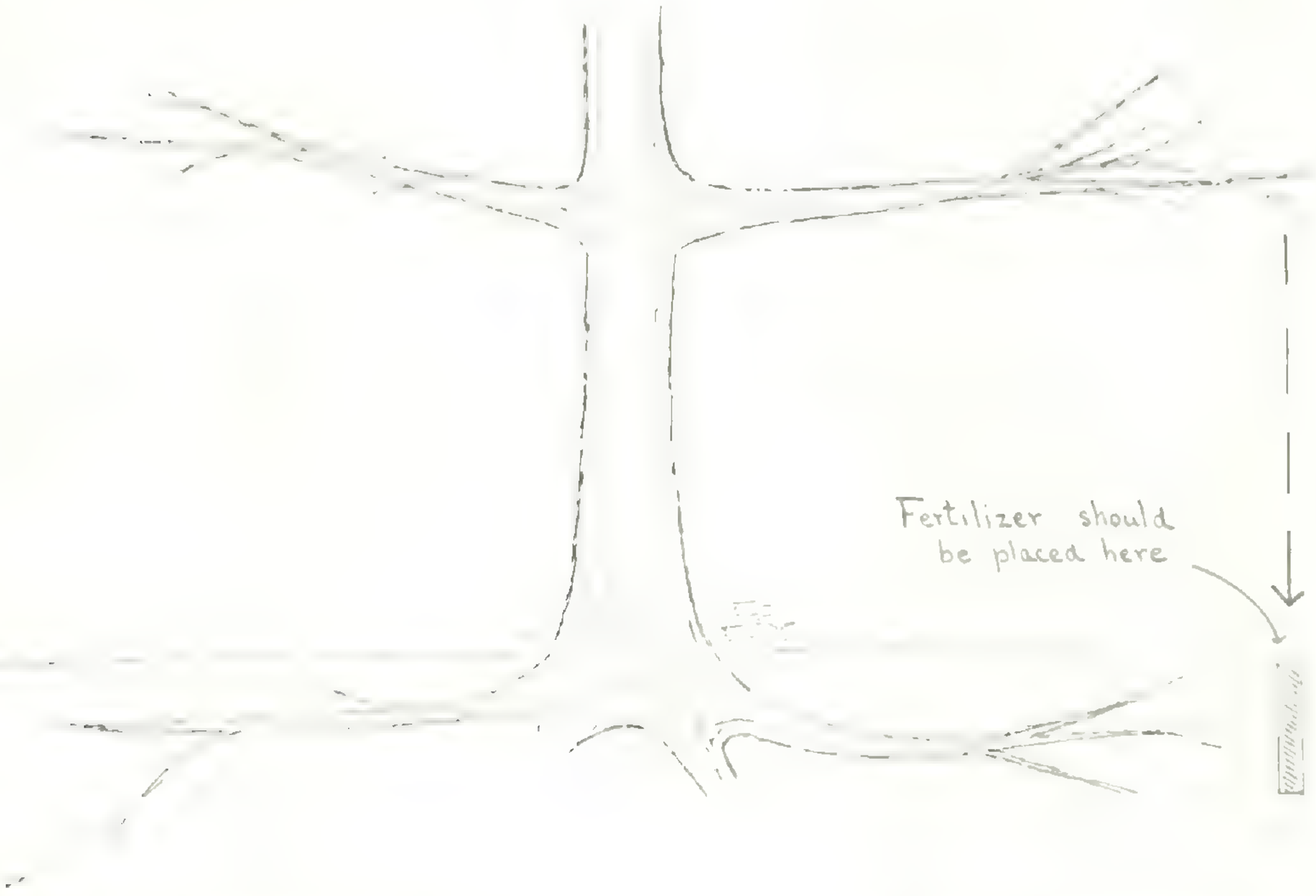


Fig. 4. Feeding roots are found under the branch tips. Place fertilizer in holes under branch tips.

manure reenforced with commercial fertilizer is a very effective method of feeding low-branched trees, especially evergreens. The bed thus formed may extend to the branch tips and can be reserved for shade-tolerant plants.

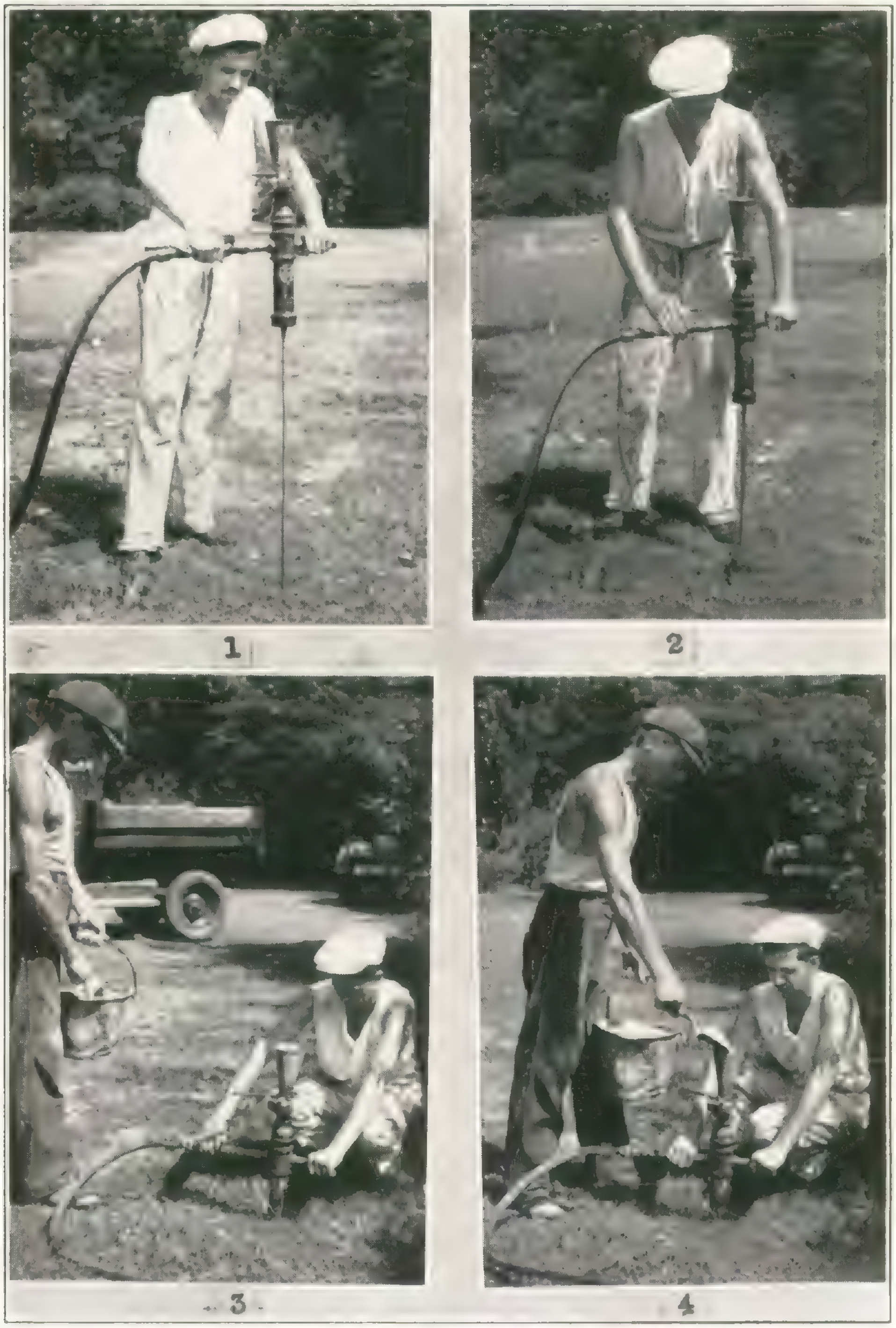
Fertilizer when injected underground in solution or forced under in a dry state is most quickly available to the tree. It is much more satisfactory than placing food in compacted holes to await a rain. A watering needle, which has been in use in the Garden for a number of years, has proved of considerable value in making holes. This is a simple device consisting of a soil rod 40

1

PLACING TROWEL OF FOOD IN PUNCH-BAR HOLE.

2

MAKING HOLES AROUND TREE BY PUNCH-BAR METHOD.



PRESSURE FEEDING GUN.

1. PRESSURE FEEDING GUN IN POSITION TO DRILL HOLE. 2. HALF-WAY. DEPTH OF FEEDING CAN BE CONTROLLED. 3. HOLE DRILLED. READY TO CHARGE CYLINDER WITH FERTILIZER. 4. SECOND CHARGE OF 1½ POUNDS BEING POURED INTO GUN.

inches long made of ¼-inch pipe. The top is fitted with a "T" which serves as a handle and inlet for water. One side is capped, and the other fitted with a stopcock to which a heavy garden hose is attached. The tip of the needle is placed in contact with the ground, and the water slowly turned on. While the water is running the needle can be forced underground to any desired depth. After the needle is withdrawn, tree food may be poured into the hole, and additional water used to wash it down. More effective feeding can be done with a high-pressure spray outfit. The fertilizer may be dissolved in the tank and the solution pumped underground through the watering needle. The corrosive action of the fertilizers when in contact with metal, and the clogging of strainers and valves with insoluble particles are objectionable features of this method.

A pressure feeding gun, developed at the Garden in 1933, combines the advantages of the watering needle and the power sprayer. This gun cannot be used at ordinary city water-pressure. To do efficient work a pump having a capacity of not less than 6 gallons per minute at 300 pounds pressure is required for each gun. Certain advantages are claimed for this method: (1) There is no corrosion or excessive wear on equipment, since the fertilizer does not come in contact with the sprayer; (2) regardless of soil conditions it is much faster than other methods; (3) the lawn is uninjured; tufts of vigorously growing grass do not mark the point of application; (4) depth of injection can be controlled; (5) the pressure and volume of water following the fertilizer accomplish a diffusion not obtained by other methods in many months; (6) rapidity of diffusion prevents concentration of fertilizers in pockets; (7) an effective impregnation of the soil occurs. This results in an immediate growth response.

A detailed drawing of this gun (fig. 5) is included for the first time in any publication. That in use at the Garden has been made from standard galvanized pipe-fittings and is easily handled. Its operation is simple. Both valves are closed until the required pressure has been built up in the sprayer, then the stop-cock controlling the supply from the sprayer is slowly opened. This fills the gun with water which is then forced out the tip of the soil rod, thus drilling the hole. In certain soils some "blow-back" of water

occurs around the soil rod. This can be prevented by the use of either a wood or cast-iron plate in which has been drilled a hole large enough to accommodate the soil-rod. The top of the plate is fitted with two thicknesses of old fire hose to serve as a gasket when the gun is fully inserted. After the hole has been drilled,

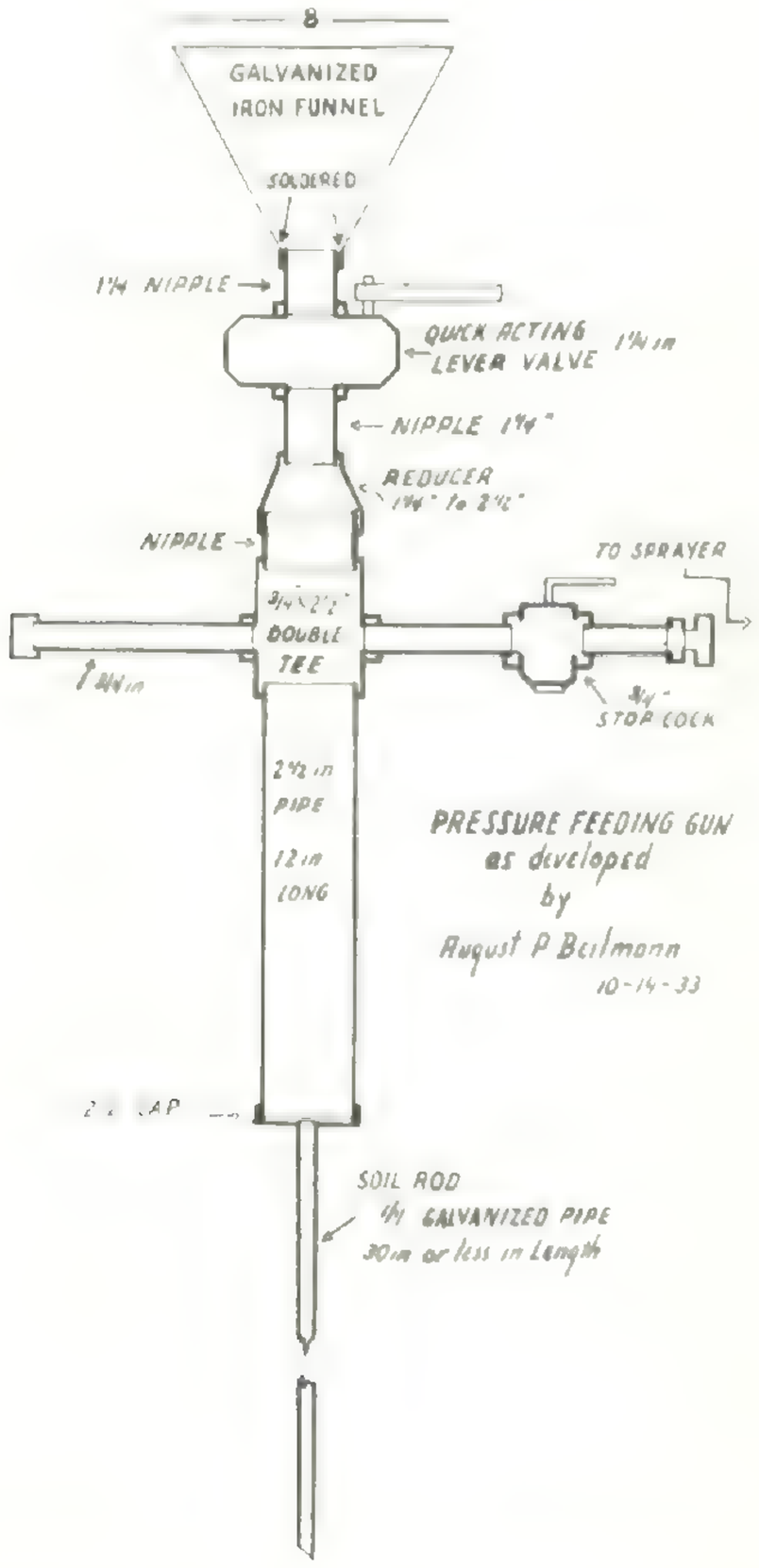


Fig. 5. Diagram of pressure feeding gun.

the water is turned off and the lever valve under the funnel opened. The fertilizer is poured into the funnel (about 1½ pounds at each charge), the lever valve again closed, and the water turned on and left running for about ½ minute. About three gallons of water (exclusive of that required to drill the hole) are used to force each charge of fertilizer underground. In the hands of a competent

operator there will be no injury to the lawn, nor will an examination disclose a pocket underground.

Efforts to feed newly planted trees have not been successful. This is partly due to a greater need for water and partly to the inadequate root system. Feeding may begin in the second year.

A more desirable tree, such as oak, sweet-gum, or basswood, can be made to grow as fast as the "weed" trees.

SUMMARY

1. Tree feeding is the most important phase of intelligent tree care. It should become the starting point in any tree preservation program.

2. Since, for practical purposes, it is impossible to determine which element may be the limiting factor, complete fertilizers containing nitrogen, phosphorus, and potash are needed.

3. A formula made up of 10 per cent nitrogen, 8 per cent phosphorus, and 6 per cent potash, 10-8-6, has proved most effective in this vicinity.

4. The correct way to calculate the dosage is to add the height (in feet) to the branch spread (in feet) to the trunk circumference (in inches). The resulting figure is the number of pounds of a 10-8-6 formula needed for that tree.

5. The most effective time for feeding is early spring—before July 1 if possible.

6. Dry fertilizers placed in compacted holes underground are not as quickly available as when forced under with water.

7. The amount of water available is not so important to the tree as the concentration of food in that water. Well-fed trees show no signs of injury during a dry season.

8. Shade trees cannot be over-fed; they require large amounts of food. The food requirements increase each year, keeping pace with the annual growth. The natural food supply decreases at the same rate, and starvation follows.

9. Since most of the elements needed for growth must be supplied by the soil, the only practical way to increase trunk diameter and lengthen twig growth is to supply the required elements through fertilizing.

A. P. B.

A SIX-WEEKS' COURSE IN FIELD BOTANY, JUNE 16 TO JULY 24, 1936

The course will be conducted at the Missouri Botanical Garden Arboretum, at Gray Summit, Missouri, on Tuesdays, Wednesdays, Thursdays, and Fridays. The building formerly used for a boys' camp will serve as an assembly hall and laboratory. It is ideally situated for such a purpose, near the mouth of a wooded valley in that part of the Arboretum which has been set aside as a wild flower reservation. Typical river-bottom swamps and woodlands are but a few minutes' walk in one direction, and limestone glades and cliffs are close at hand.

The course will consist almost entirely of study, in the field, of the native vegetation. The exact program of study will be varied to suit special requirements; it will consist for the most part of individual instruction supplemented by informal discussions and a few general lectures. There are no formal prerequisites; the course is planned to accommodate both those with previous academic training and those with none. The only requirements for admission are an active interest in the subject and a capacity for sustained work. Dr. Edgar Anderson, under whose personal direction the course will be given, is experienced in teaching groups of various ages and of diverse training but with a common interest in biology.

The Arboretum is easily accessible by automobile; routes No. 66 and No. 50 meet at the main entrance. It is hoped that enough members of the class will have automobiles so that cooperative arrangements can be made for transportation to and from St. Louis.

Registration before June 1, at the Missouri Botanical Garden Library and Administration Building, 2315 Tower Grove Avenue, upon consent of the Instructor, Dr. Edgar Anderson.

The fee is $25, $5 to be paid when registering and the balance by June 1.

Course limited to 25 students.

NOTES

The *Herbarist* (**1936:** 9-11) contains an article by Dr. Edgar Anderson, Geneticist to the Garden, on "The Tarragons, Cultivated and Wild."

Mr. Paul A. Kohl, Floriculturist to the Garden, gave an illustrated lecture, March 25, before the Garden Club of Rolla, Mo., on "Irises, Peonies, and Roses."

Dr. George T. Moore, Director of the Garden, spoke before the freshman class of Harris Teachers' College, March 18, on "Henry Shaw and His Gift to St. Louis."

Mr. G. H. Pring, Superintendent of the Garden, has written chapters on "The Cultivation of Orchids" and on "Water Gardening" in the *New Dictionary of Gardening*. He is also the author of an article on "Water Gardens" in the March 15 number of the *New York Herald-Tribune,* and one on "Success with Water-Lilies" in the *Boston Herald* of March 22.

Recent visitors to the Garden include Dr. Paul B. Sears, Head Department of Botany, University of Oklahoma, Norman, who spoke at the graduate seminar, March 25, on "The Phytogeography of the Middle West"; Prof. A. T. Erwin, Associate Professor of Horticulture, Iowa State College, Ames, Iowa; Dr. Marion Parris Smith, of Bryn Mawr College, Bryn Mawr, Pa.

Mr. G. H. Pring, Superintendent of the Garden, has given the following talks during the month: before the Kappa Delta Sunday School Class of Signal Hill Community Church, East St. Louis, Ill., March 12, on "Annuals and Perennials for the Garden"; before the Art Club, March 23, "Henry Shaw and His Garden"; before the Monday Club of Webster Groves, the afternoon of March 30, "Romance of the Plant World"; before Boy Scout Troop 198, evening of March 30, "A Trip Over the Andes of Colombia"; before the Tyler Place Presbyterian Church, April 1, "Henry Shaw and His Garden"; before the Gray Summit Garden Club, April 6, "Judging St. Louis Gardens"; before the West Presbyterian Church, April 7, "Orchids."

STATISTICAL INFORMATION FOR MARCH, 1936

GARDEN ATTENDANCE:

Total number of visitors	27,295

LIBRARY ACCESSIONS:

Total number of books and pamphlets bought	70
Total number of books and pamphlets donated	87

PLANT ACCESSIONS:

Total number of plants and seed packets donated	2,098

HERBARIUM ACCESSIONS:

By Purchase—

Erichsen, C. F. E.—Lichens of Germany, nos. 201-300 inclusive	100
Gentry, Howard Scott—Plants of Mexico	410
Hinton, George B.—Plants of Mexico	200
Lundell, C. L.—Plants of British Honduras	60
Skutch, Alexander F.—Plants of Costa Rica	411

By Gift—

Barkley, Fred A.—*Rhus Toxicodendron* L. from horticulture	1
Berry, Edward C.—Lichens of Missouri	10
Conard, H. S.—*Tortula pagorum* from Missouri	1
Demaree, Delzie—*Quercus* spp. from Oklahoma	3
Rollins, Reed C.—*Arabis* from western United States	10
Steyermark, Julian A.—Plants of Texas	15
von Schrenk, Hermann—*Ranunculus macranthus* Scheele from Texas	1
Williams, Louis O.—*Mertensia bella* Piper from Oregon	1

By Exchange—

Gray Herbarium of Harvard University—Plantae Exsiccatae Grayanae, Cent. VI, nos. 501-600 inclusive	100
Gray Herbarium of Harvard University—Photographs of types and authentic specimens of Bromeliaceae	241
Gray Herbarium of Harvard University—Miscellaneous duplicates	41
Naturhistoriska Riksmuseet, Botaniska Avdelningen, Stockholm—Miscellaneous fungi	95

By Transfer—

Missouri Botanical Garden Library—Plant illustrations	3
Moore, G. T.—*Buxus microphylla* Sieb. & Zucc. var. *koreana* Nakai from horticulture	1
Total	1,704

SOME FACTS ABOUT THE GARDEN

The Missouri Botanical Garden was opened to the public by Mr. Henry Shaw about 1860. From that date to the death of Mr. Shaw, in 1889, the Garden was maintained under the personal direction of its founder, and while virtually a private garden it was, except at certain stated times, always open to the public. Although popularly known as "Shaw's Garden" the name Missouri Botanical Garden was designated by Mr. Shaw as its official title and in his will or in any of his writings he specifically referred to it as the "Missouri Botanical Garden." By a provision of Mr. Shaw's will the Garden passed at his death into the hands of a Board of Trustees. The original members of the Board were designated in the will, and the Board so constituted, exclusive of certain ex-officio members, is self-perpetuating. By a further provision of the will, the immediate direction of the Garden is vested in a Director, appointed by the Board of Trustees. The Garden receives no income from city or state, but is supported entirely from funds left by the founder.

The city Garden comprises 75 acres, where about 12,000 species of plants are growing. There is now in process of development a tract of land of over 1,600 acres outside the city limits which is to be devoted to (1) the propagation and growing of plants, trees, and shrubs, designed for showing either indoors or outside, at the city Garden, thus avoiding the existing difficulties of growing plants in the city atmosphere; (2) gradually establishing an arboretum as well as holding a certain area as a forest reservation, with the idea that possibly at some future time this may become the new botanical garden.

The Garden is open to the public every day in the year, except New Year's Day and Christmas—week days from 8:00 a. m. until sunset; Sundays from 10:00 a. m. until sunset.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Place, on the Sarah car line (No. 42). Transfer south from all intersecting lines.

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MISSOURI BOTANICAL GARDEN BULLETIN

Vol. XXIV MAY, 1936 No. 5

CONTENTS

	Page
Some Migratory Trees	119
Washingtonia—A Desert Palm	123
Some Notes on a "Brooding" Scale Insect	126
Winter Injury to Trees and Shrubs	130
Notes	134
Statistical Information	137

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Missouri Botanical Garden Bulletin

Vol. XXIV MAY, 1936 No. 5

SOME MIGRATORY TREES

Botanical textbooks list a number of features which distinguish trees from many other forms of life. One of these differences is their inability to move from place to place. Those trees with which we have become familiar since childhood are rarely or never found skipping about the countryside. We can be positive that trees which have been growing in a certain position will remain there until death. Since this fact is so well established it is interesting to find trees which do change location and continue to grow both during and after the transition. Broadly speaking, migration may be accomplished by seeds, underground runners, or under special circumstances other methods. However, this is a long process and extends the range of the species rather than causing the actual migration of an individual.

Under certain conditions trees do move about, and this performance can be witnessed near St. Louis on the Meramec River and some of the tributary creeks. The forces involved are water (floods) and gravity, while a third one, wind, may, and often does, upset the tree and bring that individual attempt to an end. In Missouri, at least, such attempts are confined to trees growing on the edge of a steep silt bank along a water course. Usually such trees have well-developed tracing roots on that side away from the stream. When sufficiently well developed these roots support the tree while a raging flood scours several tons of soil from around the roots. With the disappearance of the soil the tree settles and may even move laterally for several feet. As the flood subsides silt may again be deposited over a portion of the root

SYCAMORE STILL GROWING AFTER MIGRATING TWO FEET DOWNSTREAM AND SETTLING ABOUT FOUR FEET

AN ELM WHICH HAS MOVED LATERALLY TWO FEET AND ALSO SETTLED

ELM TREE, TAKEN FROM OLD GROUND LEVEL, SHOWING DEGREE OF SETTLING

PORTION OF RIVER BANK AFTER SLIDE, FIFTEEN TREES HAVING BEEN TRANSPLANTED TO A LOWER LEVEL

system. While the entire root system has not been uncovered, the trunk has actually moved a considerable distance, and seemingly has suffered no ill effects. However, the number of large trees swept down stream during floods would indicate that successful migrations were the exception rather than the rule. The sycamore now growing in the creek (pl. 30, fig. 1) at one time grew several yards from the edge. Due to the continual meandering of the stream during low water and the scouring effect of floods the new bank is ten feet back of the trunk. During some past flood the gravelly substrata and finally the silty loam around the roots caved in and the tree settled almost four feet. This is clearly shown by the long brace root, which now is growing upward, and the crushed condition of the roots immediately below the trunk. This sycamore may become a transient rather than a migrant unless the meandering creek chooses to follow the old channel. Later floods may sweep away the entire tree, or a combination of wind and flood may terminate its existence.

Another tree—an elm—experienced an identical urge to travel. Fortunately for this tree (pl. 30, fig. 2), after the transition, flood water stopped using the new channel. In this case it is difficult to determine precisely how far the tree moved. The twisted roots would indicate that it moved laterally about two feet. From the upward growing root in the foreground it is evident that it also settled about four feet. The condition of the banks along this ditch shows that several years have elapsed since the change, and in the meantime the tree has had ample time to readjust itself. Such shifting about is not uncommon along the creeks and rivers of Missouri. It may involve only a single tree, or an entire bank may slide downward carrying everything with it. This occurred at Valley Park several years ago. In this instance a section, four hundred feet long, of a steep bank slid into the river. The fifteen soft maples growing on that portion of the bank were swept along. Those in the center of the slide were moved about twenty-two feet horizontally, and lowered about as much. It is remarkable that all of the trees continued to live, although some of them are now growing at the very edge of the river (pl. 31, fig. 2).

When we consider the careful preparation and the labor involved in moving a thirty-inch tree, it is amazing that this should

prove to be a common occurrence along rivers and creeks. With no particular preparation floods sweep full-grown trees into a new location, and the trees show no ill effects. A. P. B.

WASHINGTONIA—A DESERT PALM

Among the palms, we find some very noble specimens. The family itself is quite a large one, comprising over 1000 species characteristic of the tropical regions of the world. A relatively small number is indigenous to our own country, and by far the most of these are native to the southeastern states, especially Florida. Yet the most majestic of our native palms are the Washingtonias found in a wild state in the Colorado Desert of California. These palms were discovered by Dr. C. C. Parry about 1850. At that time they were growing in thousands, mostly in the rocky canyons of the San Jacinto Mountains, and many of them were nearly 100 feet tall. In the extreme west-central part of Arizona, just a few miles north of the town of Parker and within a stone's throw of the turbulent Colorado river, is probably the only grove of wild palms in that state. No one knows how this grove originated, as no other wild palms are growing anywhere in the immediate vicinity. Although Washingtonias are desert palms, they are usually found by some scanty spring, often on the mountain slopes, or in the sandy beds of dry creeks. Contrary to general belief, they require an ample supply of water and above all good drainage at all times.

At first these fan-leaved palms were known under the generic name of Brahea or Pritchardia. However, Dr. H. Wendland, one of the most noted palm specialists of his time, becoming convinced of their generic distinctness, placed them in a new genus Washingtonia, commemorating George Washington. Commonly, these picturesque palms are known by various names, as desert palm, sentinel palm, weeping palm, and Washington palm.

Throughout the southern half of Arizona, palms are extensively used in street planting. The Salt River valley in south-central Arizona, where there is an average growing season of 298 days, is noted for its date-palm culture. Because this valley is in a warm dry zone and irrigation has become possible by impounding the

waters of the Salt River in the Roosevelt Dam, this region has become a celebrated garden spot. Last September, the writer spent a few days in this delightful valley, and all along the famous Apache Trail from Mesa westward the date palms with their ripening fruit lent an enchanting touch. Most of the towns in southern Arizona line their streets with Washingtonia and Phoenix palms, where they seem to grow rapidly and vigorously to majestic proportions. In the semi-tropic climate of Phoenix, Arizona, the writer noted that the palms were very predominant among the city trees. In Tucson, huge specimens of the desert palm beautify the grounds of the University of Arizona (pl. 32, fig. 1). Especially striking are these tall, fan-leaved trees against the colorful Spanish architecture of our Southwest.

The characteristic feature of these beautiful palms is the pendant remains of dead leaves which clothe the robust trunks and remain attached for very long periods. This natural mantle protects the trunks from the scorching heat and drying winds of the desert. In cultivation, this shaggy mass is usually cut away—the excuse for this act: to give the palms a neater appearance.

As the saguaro *(Carnegiea gigantea)* was extremely useful to the Indians of the Southwest, so too the desert palm served them in a lesser degree. The fruit of the palm was eaten fresh or was dried for future use. Its leaves were used to roof their primitive habitations, while the strands of leaves were made into string and were sometimes used for weaving.

At the Garden three fine specimens of the desert palm grace the palm house. All of them were received under the name of *Washingtonia filifera,* but a preliminary check-up will probably establish at least another distinct species. In the southwest section of the palm house stands a 16-foot specimen from St. Leo's Abbey, Florida. This palm was obtained in 1915, and from all indications answers the description of *Washingtonia robusta* Parish. Its trunk is stout, enlarged at the base, almost five feet in circumference, and the upper portion is covered with the persistent bases of the old leaf-stalks. The petioles are stout and erect when young, about four feet long, broadened at the dark brown base to four to five inches in width, but gradually tapering toward the apex to about an inch. The margins of the petioles are armed for their

AVENUE OF DESERT PALMS IN ARIZONA

WASHINGTONIA FILIFERA AT THE GARDEN

entire length with stout, usually recurved spines. The leaf-blades are circular, about five feet across, divided into numerous bifid segments, and with seventy folds to each leaf-blade. The leaf itself is less deeply cleft than that of *W. filifera,* and from each cleft issues one slender filament or thread, usually sixteen to nineteen inches long.

The specimen in the southeast section of the palm house, with the exposed mass of roots, is *Washingtonia filifera* Wendland. The trunk is somewhat bulged at the base, measuring a little over six feet in circumference, and rises nineteen feet in height (pl. 32, fig. 2). Like *W. robusta,* it is covered with the persistent bases of old leaf stalks. The petioles are five feet long, seven inches wide at the bases and about two inches at the tips. The margins of the leaf-stalks are beset with lighter-colored spines only toward the base, and these seem to be less curved than in *W. robusta.* The tips of the leaf segments are typically frayed into loose tufts of slightly curled thread-like fibers. The leaf-blades are more deeply cleft than in *W. robusta,* and the threads from the clefts are also much longer, measuring twenty-two to twenty-six inches. In general, *Washingtonia filifera* is a more massive specimen than *W. robusta,* despite the latter's specific name.

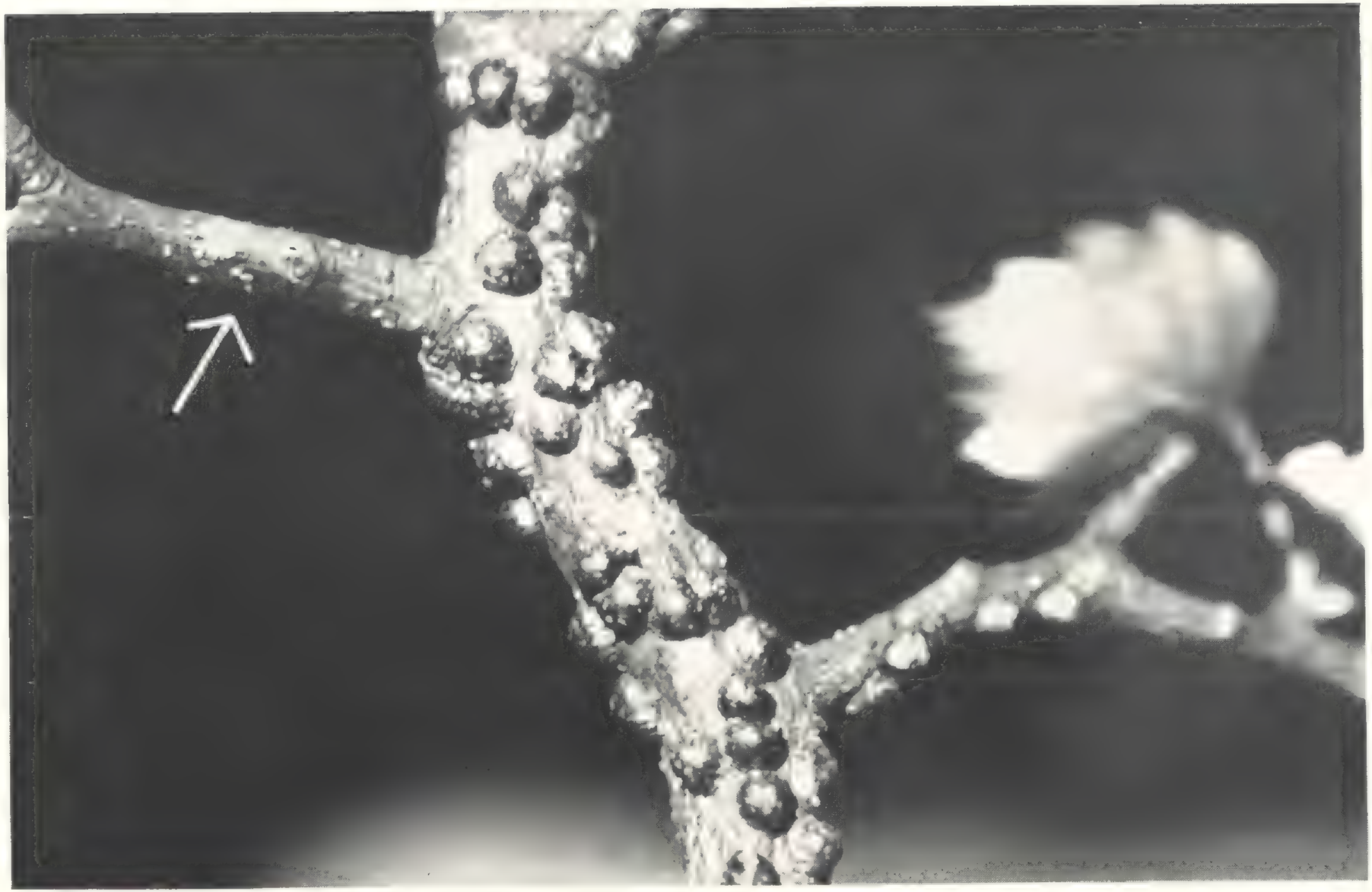
The third specimen, in the south-central bed, came to the Garden in 1918 from D. S. Brown's famous collection, and is the most noteworthy palm in the palm house. Its stout columnar trunk is 25 feet tall. *Washingtonia filifera* is a very variable species, but this palm seems to be an intermediate form between *W. filifera* and *W. robusta.*

L. C.

SOME NOTES ON A "BROODING" SCALE INSECT

During the spring of 1932, at a time when many of the hawthorns were infested with the terrapin scale *(Eulecanium nigrofasciatum)* some observations were made concerning the emergence and subsequent behavior of the young larvae. Now, after several years, these observations still seem to be worth recording, particularly so since no other published account mentions the extraordinary conduct witnessed on that occasion.

Following the late application of dormant spray, a regular



LARVAE OF TERRAPIN SCALE BEGINNING TO CRAWL AT 10:00 A. M.

"check-up" was conducted to determine the effectiveness of the material used, and perhaps during this "check-up" to discover a better time to spray. Such routine examinations usually throw some light on the "kill" obtained with the insecticide previously used and in many cases indicate more satisfactory seasons for spraying than those commonly accepted.

After several routine examinations of this sort, on June 16, larvae were seen emerging from under the shells of the mature terrapin scale. This indicated that now was an ideal time for controlling this pest, even though a different method would have to be used. Consequently, more frequent inspections were made during the day to discover what sort of position might be selected by these newly emerging larvae as a suitable place to feed. If they customarily chose the leaves rather than the new shoots this might influence the kind of material and the manner of application when control was attempted. However, it was discovered that of the many thousand emerging larvae very few appeared to settle down to feed. Most of them continued to move about. At the time this seemed peculiar, but since the study of insect behavior is as yet a comparatively untrodden field no importance was attached to it. Perhaps toward evening they would settle down, insert their beaks, and start to feed. Certainly, because of their microscopic size, they could not undertake an extensive journey without ample provisions. A careful examination disclosed no tourist camp along the path they followed up and down the branch.

The field-book notation for that date reads: "3:15 p. m. larvae still moving." An hour later another investigation was made, since spraying was scheduled to begin in the morning. The notation for that hour reads: "4:45 p. m. larvae have disappeared." This seemed to demonstrate the high mortality rate among newly hatched scale. It also showed a positive method of obtaining a "100 per cent kill" which would be simple and fool-proof. After making a careful count of the crawling larvae, simply spray with anything near at hand, and that evening pridefully point to a complete "kill." This was a bit of unusual luck and a demonstration well worth remembering. Since most economic entomologists make an occasional error, they should be given full credit even when Nature lends a hand.

About 10:30 the next morning another search was made (perhaps to see how much credit could be claimed), and very shortly a few larvae appeared. Within the next half-hour the branch was again covered with crawling young. First only a few, then more and more; finally attention was focused on just one scale. Soon tiny white crawlers began to come from under the shell, one after another with just a few seconds' intermission, until twenty-four had emerged. Another was then brought into focus and twenty-eight were counted before the adult scale was removed and found empty. During this time and shortly after most of them began their journey, an individual would occasionally be seen returning to crawl back under the scale. This was indeed a strange performance. Perhaps it held a clue to the complete disappearance the previous night. Further watching disclosed that quite a few returned to the parent scale for just a moment, then joined the mass movement toward the branch tip.

By this time the hypothesis of last night—based upon the mortality rate—was no longer tenable. Painful experience teaches the economic entomologist to proceed cautiously; it therefore seemed highly desirable to have an impeccable witness to view this performance, since the behavior observed differed greatly from the accepted theories of maternal care shown by scale insects. Mr. G. H. Pring was accordingly asked to be present at noon and again at 4:00 o'clock to witness the return, if this proved to be the customary habit. The performance began as per schedule. Shortly after 3:30 p. m. the general movement of larvae was reversed. They began to come down the branch (for some of them a journey of three feet) and to disappear beneath the mature scales. Within twenty minutes all had returned to remain safely covered for the night. The number returning was less than was observed the night before. An examination showed that many had settled along the midrib of the leaves and on the succulent shoots. Most of these had gone through the first molt and were covered with the waxy scale characteristic of this insect.

Promptly at 10:30 the next morning the emergence began, but during the afternoon relatively few of the insects were crawling. Most of them had settled permanently on the new growth. The return at 4:00 o'clock was a more orderly procedure. It involved

only a few hundred rather than the several thousand of the previous days. Unfortunately, further observations could not be made. Judging from the number of young left, most, if not all, would either have been permanently located or would have perished.

Simanton (U. S. Dept. Agr. Bull. No. 351. 1916) has published a very comprehensive account of the terrapin scale as it occurs on the peach in Pennsylvania. He has noted the time of emergence in the morning, but does not mention having seen any evidence of a return in the evening. This unique performance may have been due solely to the devitalized condition of the tree upon which the observations were made. The total new twig growth did not exceed two inches per year, and hardly more than four scrawny leaves grew from each branch tip. This alone might account for the greatly lessened production of young, and also for the apparently aimless wanderings and the final return during the night.

In recent years the terrapin scale has become an important pest of the sycamore, and occasionally attacks soft maple and hawthorn. While dormant spraying with a heavy oil will generally control most scale insects, it has little effect upon this one. This pest is most easily controlled if spraying is withheld until the young have hatched, shortly after June 20. A contact spray is necessary. Either a "summer" oil or a pyrethrum mixture, if thoroughly applied to the new growth, will prove effective.

A. P. B.

WINTER INJURY TO TREES AND SHRUBS

The winter of 1935-1936 brought unprecedented cold to St. Louis gardens. By any ordinary standard of comparison January, 1936, was a cold month; there were only two days with a temperature over 50° F., and on 23 days the minimum was below freezing. January, however, was subtropical by comparison with the first three weeks of February. During this period there were only five days when the thermometer went above freezing and on six nights it fell to zero or below. The coldest for the winter was on February 18, when 8 degrees below was recorded.

So far as plant damage was concerned there were several ameliorating circumstances. The long-continued cold prevented any of the disastrous early starts which are the usual result of unseasonable warmth. Particularly fortunate was the fact that the February cold was accompanied by snow; nearly four inches fell on February 1, and there were additional flurries throughout the month. This meant that during the entire cold wave the ground was covered by a good snow blanket which held root temperatures nearly constant. Had it not been for the snow cover it is probable that many more species would have been killed or injured.

The following lists report the damage as it could be estimated the first week in May. They are somewhat provisional, however, since an entire growing season will be required before the full extent of the damage will be apparent. Some species not on the lists have been left in a weakened condition, and a second winter of the same severity would cause additional damage.

CITY GARDEN

BRANCHES KILLED BACK

Latin name	Common name
Aesculus Hippocastanum (two specimens)	Horse-chestnut
Benzoin aestivale	Spice-bush
Baccharis halimifolia	Groundsel tree
Broussonetia papyrifera	Paper mulberry
Catalpa speciosa	Western catalpa
Catalpa bignonioides	Catalpa
Celastrus scandens	American bittersweet
Cephalanthus occidentalis	Button-bush
Crataegus Oxyacantha var. *rosea*	Paul's scarlet thorn
Euonymus alatus	Winged euonymus
Ilex cornuta	Chinese holly
Ilex Seiboldi	Siebold's holly
Magnolia Kobus	Japanese magnolia
Mahonia Aquifolium	Holly-grape
Phellodendron amurense	Amur cork-tree
Prunus Persica var. *nucipersica*	Nectarine
Pterocarya Rehderiana	Rehder's wingnut
Pterocarya stenoptera	Chinese wingnut
Quercus Robur	English oak
Quercus Phellos (may be entirely dead)	Willow oak
Quercus falcata	Southern red oak
Sapindus Drummondii	Western sapindus

LEAF BUDS INJURED

Latin name	Common name
Acer palmatum	Japanese maple
Acer saccharinum	Silver maple
Juglans mandshurica	Siberian walnut
Lonicera (all species)	Honeysuckle
Prunus sp.	Flowering cherries
Pyrus sp.	Flowering crabs
Syringa villosa	Woolly lilac

KILLED TO THE GROUND

Albizzia Julibrissin	Silk tree
Aralia spinosa	Hercules' club
Azalea Kaempferi	Torch azalea
Calycanthus praecox	Sweet shrub
Cercis chinensis	Chinese redbud
Cercis japonica	Japanese redbud
Cistus laurifolius	Rock-rose
Cydonia cathayensis	Chinese quince
Deutzia scabra	Deutzia
Elaeagnus multiflora	Elaeagnus
Forsythia viridissima	Golden-bell
Hibiscus syriacus	Shrub althaea
Ilex verticillata (small plants only)	Common winterberry
Jasminum nudiflorum	Winter jasmine
Ligustrum (most species)	Privet
Lonicera japonica var. *Halliana*	Japanese honeysuckle

FLOWER BUDS INJURED

Acer (all species)	Maple
Azalea mollis (some individuals)	Chinese azalea
Benzoin aestivale	Spice-bush
Cercis canadensis	Redbud
Cornus florida	Flowering dogwood
Forestiera acuminata	Texas adelia
Forsythia (most species)	Golden-bell
Fraxinus (all species)	Ash
Ilex decidua	Winterberry
Juglans mandshurica	Siberian walnut
Ostrya virginiana	American hop hornbeam
Platanus acerifolia	London plane-tree
Platanus occidentalis	Buttonwood
Ulmus (all early-flowering species)	Elm

ARBORETUM

BRANCHES KILLED BACK

Albizzia Julibrissin	Silk tree
Azalea amoena	Amoena azalea
Catalpa ovata	Catalpa
Celastrus scandens	American bittersweet
Cercis canadensis var. *plena* (budded plants and plants less than two years old)	Double-flowered redbud

KILLED TO THE GROUND

Latin name	Common name
Andromeda japonica	Japanese andromeda
Berberis integerrima	Barberry
Berberis triacanthophora	Threespine barberry
Berberis Wilsonae	Wilson barberry
Callicarpa japonica	Japanese beautyberry
Callicarpa Giraldiana	Girald's beautyberry
Calycanthus occidentalis	California sweet-shrub
Caryopteris incana	Common bluebeard
Castanea mollissima	Chinese chestnut
Cedrus atlantica	Atlas cedar
Cedrus Deodara	Deodar
Cedrus libani	Cedar of Lebanon
Celtis caucasica	Caucasian hackberry
Cotoneaster bullata	Cotoneaster
Cotoneaster horizontalis	Rock cotoneaster
Cryptomeria japonica	Common cryptomeria
Cryptomeria japonica var. *Lobbi*	Lobb cryptomeria
Cupressus arizonica	Arizona cypress
Cupressus torulosa var. *Corneyana*	Bhutan cypress
Cydonia cathayensis	Chinese quince
Cytisus australis	Broom
Erica carnea rosea	Spring heath
Euonymus japonicus var. *microphyllus*	Box-leaf burning-bush
Hypericum calycinum	St. John's-wort
Ilex cornuta	Chinese holly
Ilex latifolia	Tarajo
Itea virginica	Sweet spire
Liquidambar formosana	Formosa sweet-gum
Lonicera inflexa	Honeysuckle
Nandina domestica	Nandina
Oxydendrum arborea	Sourwood
Pinus echinata	Shortleaf pine
Pinus pinea	Italian stone pine
Pinus Taeda	Loblolly pine
Quercus laurifolia	Laurel oak
Salvia Greggi	Autumn sage
Sequoia gigantea	Giant sequoia
Spiraea japonica var. *Fortunei*	Fortune's spiraea
Spiraea expansa	Spiraea
Spiraea japonica var. *alba*	White Japanese spiraea
Sterculia platanifolia	Chinese parasol-tree
Vitex Negundo	Cut-leaf chaste-tree

FLOWER BUDS INJURED

Cercis canadensis	Redbud
Cornus florida	Flowering dogwood

In many cases it is difficult to distinguish between winter injury and the cumulative effect of the drought of the past several years.

Nor is it possible at this time to compile a complete list of the plants injured. For instance, *Deutzia scabra,* which usually is frozen each year, appeared in excellent condition during the last week of February, but it has been necessary since to cut it down. The extent of injury to flowering cherries and the purple-leaved plum is uncertain. They may collapse in mid-summer, at least in the city Garden. At the Arboretum both seem in excellent condition.

There seems to be a relationship between vigor and hardiness. The plant which made the most vigorous growth appears in much better condition this spring. However, since at present the problem cannot be attacked statistically, all we can do is to attempt to add to the hardiness of a plant by supplying all its food and water requirements during the growing season. Several instances might be cited which would substantiate this view; a few specimens of both the swamp white oak and the horse-chestnut were killed this winter, but these trees have been waging a losing struggle for years. The black walnuts in the orchard have been used in experimental feeding tests for so many years that the annual growth rate has exceeded that made by a normal tree in five years. It is interesting to note that not only were these trees uninjured but they unfolded their leaves one week earlier than did the unfertilized walnuts near by.

NOTES

Dr. David C. Fairburn, Research Assistant to the Garden, spoke before the St. Louis Horticultural Society, May 1, on "Plant Propagation."

Mr. A. P. Beilmann, Arboriculturist to the Garden, gave an illustrated talk to the North St. Louis Business Men's Association, April 10, on "The Feeding of Trees."

The Garden had an exhibit of fertilizing experiments at the sixth annual exhibit of the Purchasing Agents' Association of St. Louis, at the Hotel Jefferson, April 16-17.

The annual flower sermon, provided for in the will of Henry Shaw, was delivered at Christ Church Cathedral, April 26, by the Rt. Rev. Robert E. L. Strider, Bishop Coadjutor of West Virginia.

The botany class from the University of Missouri, in charge of Dr. H. W. Rickett, assistant professor of botany, visited the Garden greenhouses, herbarium, and library, May 16.

Dr. Edgar Anderson, Geneticist to the Garden, with Dr. Karl Sax, has a paper in the March number of *Botanical Gazette* (**97:** 433-476) entitled "A Cytological Monograph of the American Species of Tradescantia."

Mr. George H. Pring, Superintendent of the Garden, gave a talk before the Bloomington and Normal Garden Club, Bloomington, Ill., April 14, on "Orchids"; before the Young Women's Guild of St. Paul's M. E. Church, East St. Louis, Ill., May 6, on "Romance of the Plant World"; and before the Men's Fellowship Club, Edwardsville, Ill., May 19, on "The Beautification of Home Gardens."

Dr. George T. Moore, Director of the Garden, spoke before the Brotherhood of Pilgrim Congregational Church, April 20, on "Flowers that Bloom in the Spring"; before the Practical Arts Club of College Women, April 24, on "My Garden and Yours"; before the St. Louis Civitans, May 1, on "Mr. Shaw and His Garden"; and before the Garden Club of Louisiana, Mo., May 18, on "What Goes On in the Plant."

Dr. Hermann von Schrenk, Pathologist to the Garden, spoke before the University of Illinois student chapter of the American Society of Civil Engineers, April 8, on "College Education and Subsequent Careers"; and on "Engineering Education," before the Missouri section of the Society for the Promotion of Engineering Education at Washington University, April 18.

Recent visitors to the Garden include Mrs. Henry Herbert Buxton of Peabody, Mass., secretary of the National Council of State Garden Clubs, and known for her interest in begonias; Dr. Norman C. Fassett, professor of botany, University of Wisconsin; Dr. W. O. Richtmann, professor of pharmacy, University of Wisconsin; Dr. H. W. Rickett, professor of botany, University of Missouri; Mr. C. E. Foweraker, lecturer on forest ecology, Canterbury College, Christ Church, New Zealand; Dr. Naomasa Shimotomai, professor of botany, Hiroshima University, Hiroshima, Japan.

Mr. John H. Kellogg, Plant Collector to the Garden, has recently found the field madder (*Sherardia arvensis*) growing near Eagle Rock, Missouri, along the roadside. This dainty European waif, though naturalized at several points along the Atlantic Coast, is very rare in the Middle West and has not previously been reported from Missouri. It is a low-growing plant somewhat like a speedwell in general aspect, with whorled leaves and pinkish-blue flowers.

Mr. L. P. Jensen, Manager of the Garden Arboretum at Gray Summit, has given the following talks recently: "Roadside Planting," March 26, before the Washington Chamber of Commerce, Washington, Mo.; "New and Interesting Trees and Shrubs at the Arboretum," April 6, before the Garden Club of Gray Summit; "Conservation of Native Plants," April 24, before the students of Webster Groves High School; "Fifty Years of Gardening and Nature Study," April 25, before the St. Louis Naturalists' Club.

Dr. Edgar Anderson, Geneticist to the Garden, made the following talks while on a recent collecting trip in the South: April 16, before the New Orleans Academy of Science, "Botanical Gardens"; April 23, at a joint meeting of the Sem Bot and Sigma Xi, of the University of Oklahoma, "Plant Collecting in the Balkans"; April 24, before the general assembly, Oklahoma College for Women, Chickasha, on "Plant Hunting in the Balkans"; April 28, before the chapel assembly, College of the Ozarks, Clarksville, Arkansas, "Science and Nationalism in the Balkans."

The following groups of visitors have been conducted through the Garden recently: two classes from the Junior College, Flat River, Mo., one on March 21, the second on April 25; the American Physical Education Association, on tour of the city, April 17; the American Society of Orthodontists, April 22; the senior class of Monticello Seminary, Godfrey, Illinois, April 28; a party of 70 students from the Depos High School, Eaton, Indiana, April 29; more than 100 delegates from the state of Texas, including the governors of Texas and Oklahoma, May 5; the Vocational Home Economics Club of Metropolis, Ill., May 14; the senior class of Alton High School, Alton, Ill., May 16; the Medora Township High School, Medora, Ill., May 19.

The ladies attending the meetings of the American Psychiatric Association, May 5-9, came to the Garden on May 7. After being shown through the Garden by guides they assembled at the lecture hall where Dr. Moore gave a talk on moving pictures of plant life, showing the films taken under the microscope, and Mr. Kohl also showed motion pictures in color of various features of the Garden, including flower shows, outdoor displays, etc.

STATISTICAL INFORMATION FOR APRIL, 1936

GARDEN ATTENDANCE:

Total number of visitors	36,779

LIBRARY ACCESSIONS:

Total number of books and pamphlets bought	44
Total number of books and pamphlets donated	406

PLANT ACCESSIONS:

Total number of plants and seed packets donated	2,004

HERBARIUM ACCESSIONS:

By Gift—

Anderson, William E.—*Passiflora incarnata* L. from horticulture	1
Barkley, F. A.—*Collinsia verna* Nutt. from Missouri	2
Boyce, J. S.—Fungi from western United States	2
Darrow, Robert—Lichens from eastern United States	57
Drouet, F., by R. E. Woodson, Jr.—Apocynaceae from Brazil	5
Graham, E. H.—Plants of Utah	25
Lowe, Josiah—Lichens of New York	7
Metcalf, Franklin P.—Photograph of *Stauntonia alata* Merrill	1
Moore, D. M.—Specimens and photographs of plants of Arkansas	8
Thompson, J. William—Plants of Washington collected by J. C. Otis	19

By Exchange—

Field Museum of Natural History—Plants of Hawaii	3
Maguire, Bassett—Plants of western United States	214
Total	344

SOME FACTS ABOUT THE GARDEN

The Missouri Botanical Garden was opened to the public by Mr. Henry Shaw about 1860. From that date to the death of Mr. Shaw, in 1889, the Garden was maintained under the personal direction of its founder, and while virtually a private garden it was, except at certain stated times, always open to the public. Although popularly known as "Shaw's Garden" the name Missouri Botanical Garden was designated by Mr. Shaw as its official title and in his will or in any of his writings he specifically referred to it as the "Missouri Botanical Garden." By a provision of Mr. Shaw's will the Garden passed at his death into the hands of a Board of Trustees. The original members of the Board were designated in the will, and the Board so constituted, exclusive of certain ex-officio members, is self-perpetuating. By a further provision of the will, the immediate direction of the Garden is vested in a Director, appointed by the Board of Trustees. The Garden receives no income from city or state, but is supported entirely from funds left by the founder.

The city Garden comprises 75 acres, where about 12,000 species of plants are growing. There is now in process of development a tract of land of over 1,600 acres outside the city limits which is to be devoted to (1) the propagation and growing of plants, trees, and shrubs, designed for showing either indoors or outside, at the city Garden, thus avoiding the existing difficulties of growing plants in the city atmosphere; (2) gradually establishing an arboretum as well as holding a certain area as a forest reservation, with the idea that possibly at some future time this may become the new botanical garden.

The Garden is open to the public every day in the year, except New Year's Day and Christmas week days from 8:00 a. m. until sunset; Sundays from 10:00 a. m. until sunset.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Place, on the Sarah car line (No. 42). Transfer south from all intersecting lines.

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OF THE MISSOURI BOTANICAL GARDEN

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Assistant to the Director

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Geneticist

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Curator of Herbarium

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ERNEST S. REYNOLDS,
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Mycologist

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Consulting Landscape Architect

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JOSEPH LANGEN,
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MISSOURI BOTANICAL GARDEN BULLETIN

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CONTENTS

	Page
A Tour of the Missouri Botanical Garden	139
Notes	159
Statistical Information	160

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HENRY SHAW, 1835

Missouri Botanical Garden Bulletin

Vol. XXIV JUNE, 1936 No. 6

A TOUR OF THE MISSOURI BOTANICAL GARDEN

The Garden is hidden away from the outside world by sturdy old-fashioned limestone walls, so high that the passer-by catches only tantalizing glimpses of tree tops or of vines which spill down over the gray-white stones. One enters through the Main Gate on Tower Grove Avenue, opposite the appropriately named Flora Place. The original entrance has had to make way for a more commodious building, but the architect has been able to preserve much of the spirit of the original and still make provision for the hundreds of thousands of visitors who every year pass through the cheerfully clicking turnstiles. Over the entrance can be seen the quaintly lettered stone taken from the original gate. It bears the official designation selected by Henry Shaw, "Missouri Botanical Garden," and the date of its erection, 1859.

Immediately before the entrance stretch the Tropical Lily Pools. From July until frost these contain the finest display of tropical water-lilies ever brought together. In the early morning and late afternoon and on cool, damp days the night-blooming water-lilies hold the stage with their large, waxy petals of pink and white. All of these varieties have been developed at the Garden, the pure white "Missouri," the pink variety "Mrs. George C. Hitchcock," and the darker red "Frank Trelease." The Garden is justly proud of these introductions but the glory of the display is the newer and less commonly grown day-blooming, tropical hybrids. These magnificent flowers, wider than dinner-plates and in exquisite shades of yellow, pink, and lavender, have largely been developed at the Missouri Botanical Garden. Out-

standing among the varieties produced here are "Mrs. G. H. Pring," with very large flowers of pure white; the pale-pink, large-flowered "General Pershing"; "Mrs. Edwards Whitaker," with enormous flower petals of soft lavender-blue cupped around the golden stamens in the center; and most interesting of all, the new hybrid yellow lily, "Saint Louis." After the earlier varieties had been originated, the Garden sought to extend the color range to other shades besides the original pinks, blues, and whites. The only possibility of obtaining a new "break," as the plant breeders say, seemed to be through the introduction of a species with bright yellow flowers which was known to be native to the muddy ponds of equatorial Africa. It was not in cultivation and only after a series of unsuccessful attempts was the Garden able to procure this "lost yellow lily" for its collection. The species itself proved disappointingly difficult to grow, but from it by cross-breeding there has been obtained a whole new series of water-lilies, the most outstanding of which has been named "Saint Louis" (U. S. Plant Patent No. 55). This variety has large, handsomely shaped flowers of an attractive shade of light yellow which forms a pleasing contrast to the pinks and blues of the older varieties.

To the right of the Lily Pools a shrub-bordered pathway leads to the Rose Garden, at its loveliest in May and June but attractive at all times of the year by reason of its excellent design. The center of the Rose Garden is a converging point for all the main pathways in this part of the Garden, and in whichever direction one looks the pathway frames a view. To the west is the shrub-bordered walk ending in the arched entrance to the Floral Display House. The adjoining pathway shows at its terminus a pleasing glimpse of the dignified, white pillars of the Palm House. Particularly noteworthy is the treatment of the vista to the south. In this direction one looks down rose-bordered stretches of turf to the perennial and shrub gardens of the Knolls and sees in the distance the square, white tower of Mr. Shaw's old home, "Tower Grove." By a clever technical trick the landscape architect has caused the water-lily pools and their attendant walks to be lowered just enough so that they are not visible from the Rose Garden, thus preventing a discordant cross-wise streak through the center of the picture.

MAIN GATE AND LILY POOLS

AIRPLANE VIEW OF MISSOURI BOTANICAL GARDEN

In the opposite direction is the LINNEAN HOUSE, the only remaining greenhouse which was erected in Mr. Shaw's day. It is so named because it bears over its main entrance portrait busts of three outstanding naturalists, Nuttall at one side, Asa Gray at the other, and crowning the gable, the great Swedish botanist, Linnaeus. A tablet high overhead informs us that the building was formally dedicated in 1881, "to Linnaeus the Prince of Nature," by Dr. George Engelmann, one of the greatest botanists of his day, a German emigré who made his home in St. Louis and was the close friend of Henry Shaw. The building itself is interesting as one of the few remaining examples of middle nineteenth century greenhouses. Compared to a modern greenhouse there is much more brick and much less glass, and there are intricate fan-lights over the doorways. The Linnean House is filled with a collection of camellias, genistas, and other winter-flowering shrubs, planted to simulate an outdoor garden, and from January to March is a continuous bower of blossom.

Around the Linnean House on three sides extends the LINNEAN GARDEN, largely of perennials. Particularly to be noted here is an unusually fine specimen of the sweet bay, *"Magnolia glauca,"* which shades the center of the east garden. Its glossy leaves remain late in the fall and in late May and early June its creamy white flowers fill the air with their heavy tropical scent.

One can pass directly from the Rose Garden to the FLORAL DISPLAY HOUSE or go by way of the gate in the west wall of the Linnean Garden and down a curving flagstone path through the shrubbery. As its name indicates, this house is used for big displays or flower shows which are staged from November to April. Highest in popular favor are usually the Chrysanthemum Show, in the fall, and the Orchid Show, shortly after Christmas, which often draw more than ten thousand visitors in a single day. The Garden is nationally known for its orchids which are exhibited *en masse* during the Orchid Show and are always on display at other times of the year in the range of houses beyond the Floral Display House. Over 10,000 blooms are displayed in the course of a year. Starting with the gift of the D. S. Brown orchids in 1918 the collection was greatly augmented through special trips made in South and Central America by Mr. G. H. Pring.

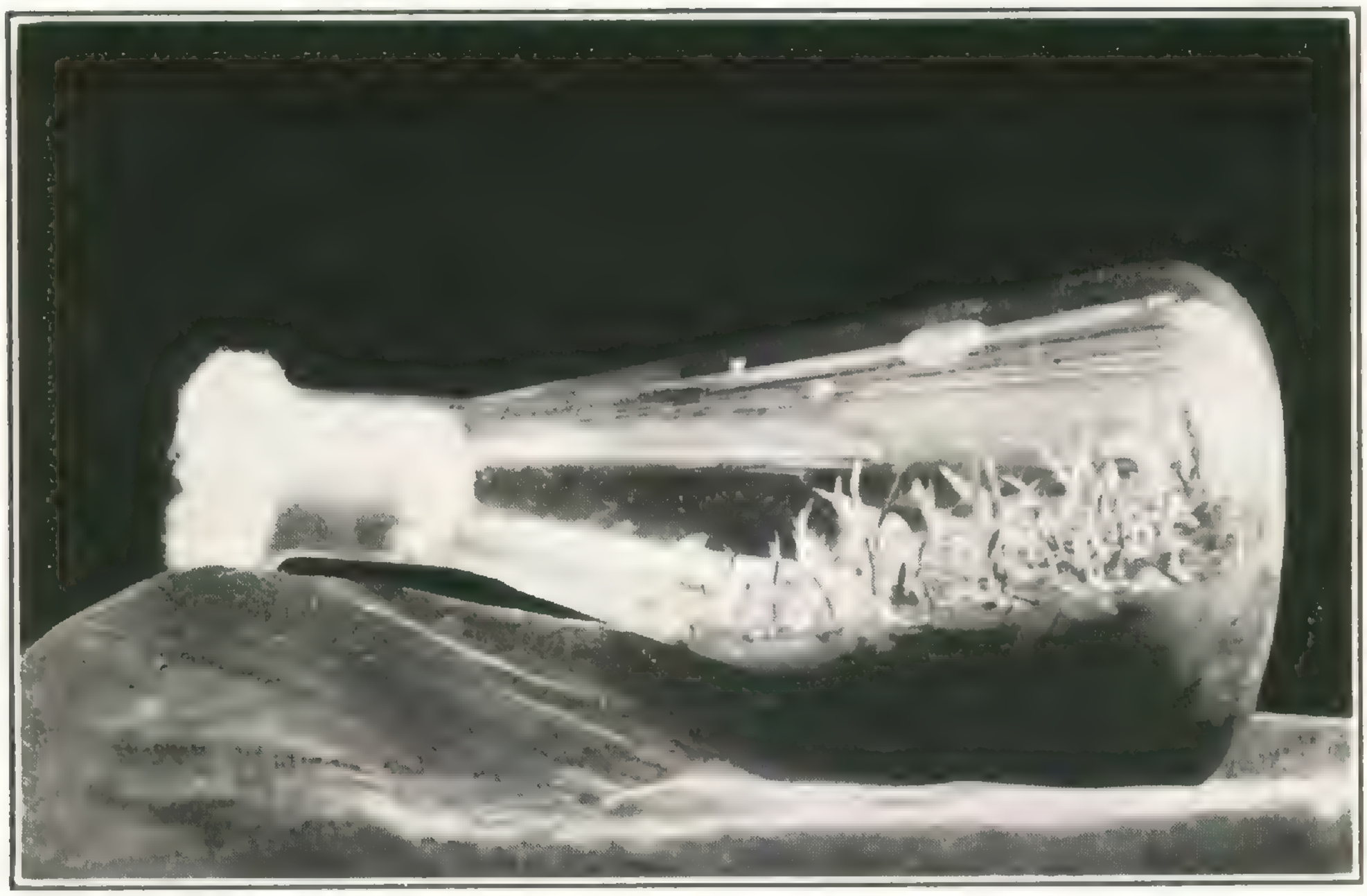
More recently the Garden has undertaken the breeding and culture of orchid hybrids, a process of such great technical difficulty that it is seldom attempted. After the cross is made and

DENDROBIUM FIMBRIATUM VAR. OCULATUM

Photograph by Alexander Piaget

the tiny, powder-like seed has been sown in hermetically sealed glass incubators, there must be 5 to 7 years of watchful care before the hybrids are brought to flowering size. From the gelatin mix-

DANCING GIRL ORCHIDS
Flowers of *Oncidium stipitatum* arranged as a ballet



CYMBIDIUM HYBRID SEEDLINGS, 4 MONTHS OLD

ONE OF THE ORCHID SEEDLING HOUSES AT THE ARBORETUM

ture on which they are first artificially nourished they must be transplanted into tiny flower-pots scarcely larger than a thimble, and from these gradually stepped up into larger and larger containers, all this time requiring daily care. The first of these hybrids reached flowering age in 1934 and by their size and brilliance justified the years of painstaking effort which had gone into their production. Orchids do not thrive under city conditions, and the Garden has a whole range of orchid houses at the Arboretum, Gray Summit, Missouri, at the junction of Highways 66 and 50. There the orchids are grown, some 25,000 plants of them, and are brought into the city Garden for display purposes. The Arboretum is gradually being developed as an adjunct to the city Garden. A thrifty young pinetum has been established and large nurseries are raising trees, shrubs, and perennials for both the city Garden and the Arboretum. It is hoped that the grounds may be opened to the public before many years.

From the upper court of the Floral Display House one can pass to either of two greenhouses on a lower level, the Citrus House and the Aroid House, which are in reality one big greenhouse separated by a wall. At their western end one turns to the right through the Bromeliad House. Here will be seen large specimens of the stilt plant, Pandanus, often grown in a very dwarfed condition in flower boxes but here developing as it does in the tropics, held high above the ground on strong roots or "stilts." As the name would imply, this house also contains a fine collection of Bromeliads, curious plants with queer, brightly colored flowers. Most of them are tropical and are ordinarily found growing in tree tops, nourished by the water which collects at the base of the leaves. Many of the Bromeliads in this collection will be seen to be more or less funnel-shaped and there is usually water in the "funnel," justifying the popular name of "tank plant." A few of the plants in this family have a somewhat different aspect, notably the pineapple and the Spanish moss or "Santa Claus's whiskers."

We pass on into the Plant Curiosities House, a veritable garden of freaks, a "believe-it-or-not" greenhouse in which have been brought together plant oddities from all over the world. Here will be found the parachute flowers, the artillery plant which

shoots its seeds, the climbing onion, and the mother-in-law's tongue, the rat-tail plant, the dumb cane (if one bites the leaves the tongue swells so that speech is impossible), the babes-in-the-cradle, and the tropical pitcher-plants which, at the tips of their long leaves, bear cunningly designed traps for unwary insects.

SACRED LOTUS OF INDIA

We may reach the main range of greenhouses either by retracing our steps to the Floral Display House or by leaving through the west door of the Citrus and Aroid House. In the summer this latter is the more interesting route, particularly when the sacred pink lotus of India is in bloom in the LOTUS POND just at the right. At the left a walk leads us by the collection of ROCK PLANTS

and the HARDY WATER-LILIES to the MEDICINAL GARDEN. Here such of the medicinal herbs as can be grown out of doors in this climate are cultivated in neat beds, with complete labels telling the main purposes for which each plant is used. To many visitors this is one of the most interesting parts of the Garden. There are many plants here which one has smelled or tasted but never seen growing: dill, anise, rosemary, lavender. There are ancient herbs which one ordinarily knows only from books, such as woad (*Isatis tintoria*), the curious little plant with which north Europeans used to dye their clothes and their bodies some 2000 years ago.

From the Medicinal Garden we can enter the PERGOLA by either end or by climbing the flight of steps in the central archway. It forms a pleasantly shaded terrace from which to view the ITALIAN GARDEN, a formal arrangement of flower beds in a precise geometrical pattern, centered about a statue of Juno which Mr. Shaw imported from Italy, the original being in the National Museum at Naples. Instead of boxwood which is the traditional hedge plant for such gardens, a hardier shrub has had to be used because of the climate. By keeping it low and by careful and frequent shearing the common California privet has been made into an effective substitute.

To the left of the terrace will be seen the brilliant metallic leaves of the copper beech, a particularly fine specimen of a variety of the common European beech. In the distance rise the slender spires of the bald cypress, native to the swamplands of the South.

Crossing the Italian Garden at the left we begin the circuit of the Main Greenhouses. We first pass through a coffee plantation, designed to simulate the actual conditions under which coffee is usually grown. The coffee plants themselves are large bushes with fine glossy leaves, white flowers, and dark-red berries. Rising above them and supplying the necessary shade are banana trees and papayas. At the further end of the same greenhouse is a collection of SOUTH AFRICAN PLANTS, distinguished by their strikingly grotesque forms. Growing as they do in desert regions where rainfall is scarce and where high temperatures prevail, they have adjusted themselves to these peculiar conditions. They

all possess thickened leaves and stems in which water is stored; upon this reservoir the plant relies in times of drought. To safeguard the water supply, they are provided with an impervious layer which covers the entire surface. Among the interesting desert dwellers gathered here are the aloes, native to Africa or to its outlying islands. Some species attain the size of large trees but the great majority are low-growing. From certain species is extracted the "bitter aloe" of commerce. Another conspicuous group of plants is the mesembryanthemums. Some of these have thick, tongue-shaped leaves; others are peculiarly constructed so that they somewhat resemble miniature jaws; still others are of the rambling type, making mats of green and blue and in season producing daisy-like blossoms of yellow, orange, red, white, rose, or purple. The wax plant, *Hoya carnosa,* with its shining, succulent leaves, is seen twining about an improvised trellis. When in bloom, its handsome wax-like flowers make this old-time favorite even more lovely.

A short flight of steps leads into the Fern and Cycad House. Here are to be found tropical ferns though city conditions make it difficult to grow some of the more beautiful species. There is, however, a really fine collections of the curious plants known as Cycads. These are an ancient type, much more common in former periods of the earth's history than they are now. Superficially, many of them look like palms but most botanists consider them a sort of missing link between the ferns and the flowering plants. Certain African species are used as food by the natives and are known as "Kaffir bread." One of the common Japanese species, *Cycas revoluta,* the sago plant, has beautiful palm-like leaves which are dried and shipped to this country where they are largely used in making memorial wreaths and similar decorations. Growing along the girders of this greenhouse is an interesting tropical grape, *Cissus sicyoides* var. *Jacquini.* From the axils of its leaves there arise thread-like roots which grow down until they reach the soil far below. Those successful enough to find a good roothold then thicken considerably and serve as an additional supply of food and water for the leaves overhead.

The central portion of the Main Greenhouses is given over to Palms. Here will be found among others the date palm, the oil

palm (which supplies the palm oil used in the manufacture of soap), the sugar palm, a source of sugar and also largely used in the tropics in the manufacture of palm wine, and the Chinese fan palm, which supplies both the common palm-leaf fans and the equally common strips of leaf for Palm Sunday. One of the most interesting of the palms will be found here, the tagua palm, *Phytelephas macrocarpa,* whose heavy white seeds are the so-called vegetable ivory used in the manufacture of buttons and other small ornaments. From either of the porticos of the Palm House there are vistas so beautiful that most visitors will wish to step out for a moment and enjoy them. To the right the west portico looks down on the Italian Garden with its brightly patterned flower-beds, its beautiful old statue, and its tinkling wall fountain. To the left, the east portico looks back down the lily pools to the Main Gate.

Continuing through the greenhouses we come to the Economic House where a number of tropical plants of great economic importance are grown, perfume plants, rubbers, tropical fruits, such as the mango and the avocado pear, the tung-oil tree, *Aleurites,* the Balsa tree whose timbers are seven times lighter than cork, the chicle tree, *Achras Sapota,* from whose sap our common chewing-gum is manufactured, and the kapok tree whose silky seeds are made into mattresses and life-preservers. From the other end of this house a flight of steps leads us down to the main collection of Cacti and Succulent Plants. Here will be seen some of the most bizarre and grotesque forms of the plant world, such as the agaves or century plants which provided the Aztecs with food, drink, clothing, and writing materials. From the sap an intoxicating drink, "pulque," was fermented; the cores were roasted and eaten; the leaves were used as roofing thatch, and the thorns were used for pins and needles. On the right is a group of plants looking so much like real dumplings that one could almost eat them. However, should one do so strange color visions would pass before the eyes for this is the "peyote" of the southwestern Indians, from time immemorial used by them in their religious rituals. The barrel cactus, another interesting plant of the desert, yields a sufficient amount of water from its inner pulp to have proved a life saver for many a heat-crazed

A MIMIC PLANT, PLEIOSPILOS SIMULANS

STAPELIA GIGANTEA, THE GIANT CARRION FLOWER OF SOUTH AFRICA

traveler on our American deserts. The "saguaro," largest and stateliest of the cacti, is also represented in the collection. Nearing the exit door, the carrion flowers, known botanically as Stapelias, will attract our attention. These cactus-like plants are really closely related to the milkweeds and have beautiful, star-like flowers, but unfortunately they emit an unpleasant fetid odor which attracts the flies, the pollinating agents for these

CENTRAL PATH, ECONOMIC GARDEN

curious plants. The euphorbias, or spurges, also occupy a prominent place in the rear part of the house. These interesting African succulents simulate the cacti in all outward appearances and yet there is no close relationship.

Again we walk through the corner of the Italian Garden and up to the shaded brick terrace of the pergola. To the left, a broad gravel walk leads us to the Economic Garden, really a succession of little gardens on a series of terraces, with a central pathway shaded by espaliered trees. This method of training fruit trees over a trellis is very commonly practised in north Europe, where the summers are so short and cool that apples and peaches need all the available sunshine if they are to be ripened

to perfection. In our hot, sunny climate the method is more interesting than useful, but the arches lend an old-world atmosphere to the garden and shade the walk effectively. On several of the terraces important or interesting crop plants are grown in small demonstration beds. Here will be found cotton, flax, corn, broom-corn, upland rice, peanuts, clover, field-peas, and such unusual crops as ramie (Chinese silk linen), unicorn plant, and udo,

IRIS GARDEN

the Japanese substitute for asparagus. On the central terrace are four back-yard gardens, plots the size and shape of a city back-yard, demonstrating what can be done with such an area under city conditions. Particularly notable is the first one to the left, planted as a city rose garden. In design and execution it is a little masterpiece and has received favorable comment from leading rosarians as an example of what can be done with roses under very difficult conditions. On another terrace will be found a collection of ornamental grasses which are hardy in this climate.

Continuing down the central pathway we pass a small pool

which terminates the Economic Garden and we catch glimpses of the IRIS GARDEN ahead. Over a thousand varieties of bearded irises have been brought together in one large planting, and from late April to the middle of May it is the most colorful spot in the Garden.

Beyond the Iris Garden rises the brick ADMINISTRATION BUILDING containing the library, offices, and herbarium, and close at hand is the Experimental Greenhouse, neither of these buildings being open to the public. The north end of the Administration Building was once Mr. Shaw's city home at Seventh and Locust streets in what is now downtown St. Louis. It was moved to this site in accordance with the provisions of his will and with subsequent additions it houses the Botanical Library founded by Mr. Shaw, the Scientific Laboratories, and the Herbarium, or collection of dried specimens of plants. It is here that work of scientific discovery is carried on, as Mr. Shaw had directed it should be. He would be proud to know that by reason of this work his Garden has made a name for itself throughout the scientific world.

We have now reached the "OLD RESIDENCE," "Tower Grove," which Henry Shaw built for a country home in 1849. A part of the lower floor is open to the public on week-days from 10 to 12, and from 2 to 4. The old-fashioned rooms with their high ceilings and marble fire-places form an effective background in which are displayed portraits of Henry Shaw, various articles belonging to him, and documents relating to him and to the Garden.

He was a native of England who came to St. Louis in 1819 and in a few decades amassed a comfortable fortune. He then retired from business, travelled widely, and developed his country estate until it became a real Botanical Garden. Not only did he grow choice collections of plants but he commissioned his friend, Dr. George Engelmann, to purchase the books and herbarium specimens which were the foundation of these collections. He built a Museum to house them, a quaint red-brick building which will be seen just to the right as one leaves Mr. Shaw's old residence. The MUSEUM is not ordinarily open to the public, but it has been fitted up as an auditorium and is used as a meeting place for horticultural and botanical societies and for lectures to the general public.

Immediately before us is the shady grove surrounding Mr. Shaw's MAUSOLEUM. Here, at his request, he was buried, in a tomb executed by Ferdinand Miller of Munich, a few years be-

WINTER VIEW OF OLD RESIDENCE AND MAUSOLEUM GROUNDS

fore Mr. Shaw's death. In the mausoleum grounds is a collection of oaks, under which has recently been developed an interesting series of ground covers. There are several strains of ivy, includ-

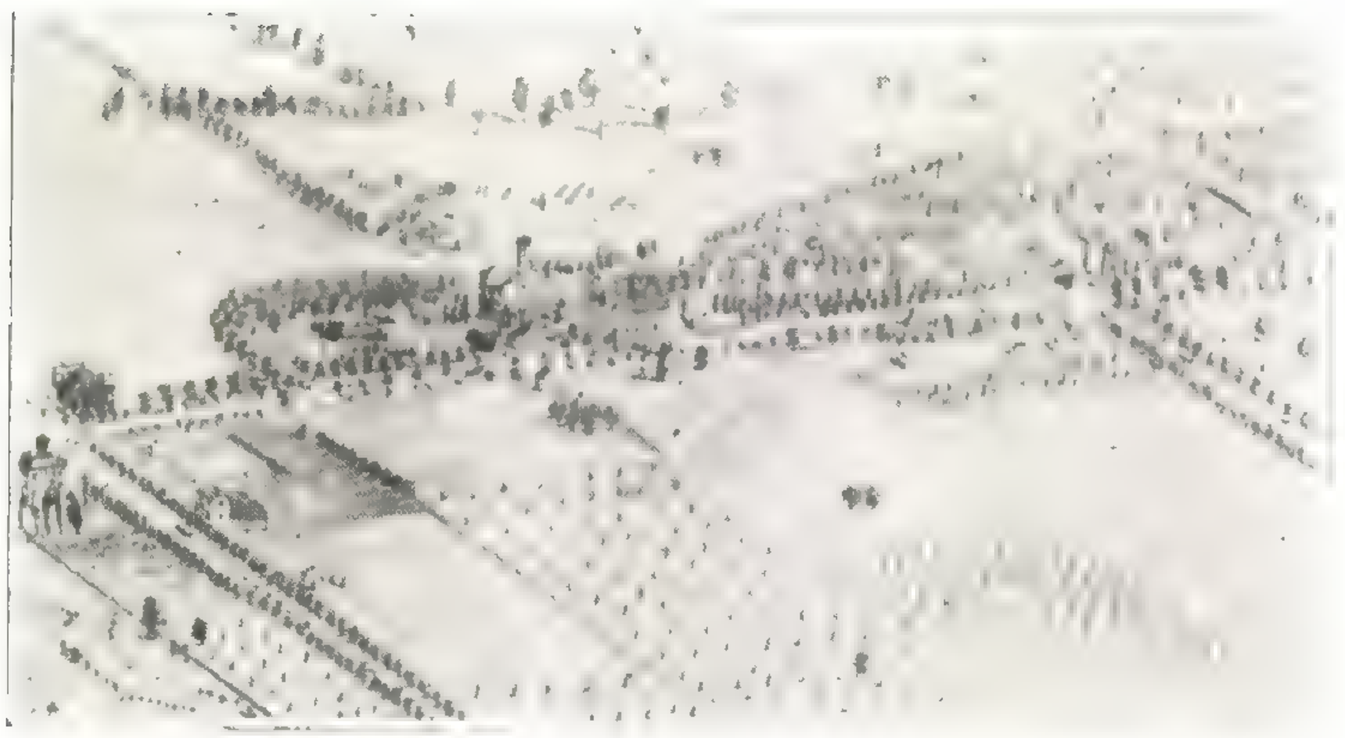
ing the hardier "baltic ivy," snake grass, day-lilies, gill-run-over-the-ground, and periwinkle.

From the further end of the Mausoleum grounds there is a long vista through the Garden to the Linnean House in the distance. In the immediate foreground are the KNOLLS, an informal arrangement of shrubs and perennials. We may return to the Main Gate either by following the grassy paths through the Knolls or by a curving gravel walk at the right. This soon brings us to a fine group of *Ginkgo biloba* (maidenhair trees), a species introduced into this country from the Orient where it has long been the object of veneration and is a frequent sight in the grounds around old temples. It is a remnant of a whole group of plants which flourished some millions of years ago but which have perished along with the giant animals of the same period. Even in China it has been exterminated as a forest tree and would have suffered the fate of its fellows had it not been for the Buddhist monks. Strangely enough, it takes kindly to modern city life and its fantastic branches and delicately shaped leaves are an ornament to the Garden as well as an object of scientific study. So long ago did this type of tree flourish in the world's forests and so completely have all the other members of its family been exterminated that one may well join Charles Darwin in calling it a "living fossil."

Just beyond the ginkgos are a group of paper mulberries, a species which has long been used in China and Japan in the manufacture of fine grades of paper. A little farther on at the left is the strongly ribbed, red-brown trunk of an old Osage orange, a species often grown as a hedge plant but seldom allowed to develop into a tree. It is the "Bo-dark" (Bois d'arc) of the early settlers, a tree whose wood was used by the Indians in making bows.

We have now made a circuit of the principal features of the Garden, and the Main Gate comes again into view. There are many things we have rushed by and many interesting points which there has not been time to mention. We should like to tell you about the double-flowered red-bud, to show you the "Before and

After" gardens near the Palm House, to point out the pygmy water-lilies, to take you around the North American tract, and to discuss our Tropical Station at Balboa in the Canal Zone. Won't you come again? And as we bid you good-bye and assure you that we, too, have enjoyed the walk around the Garden, may we point with pride to this old-time view of a wind-swept prairie farm on the outskirts of the city. It shows the beginnings of the Missouri Botanical Garden as they appeared in 1875.



NOTES

Dr. E. E. Naylor, Assistant Professor of Botany, University of Missouri, Columbia, is spending the summer in research, in the Garden library.

Mr. Ladislaus Cutak, in Charge of Succulents at the Garden, gave an illustrated lecture "Vagabonding in the Southwest," May 18, before the Topeka Horticultural Society, Topeka, Kansas.

Dr. Edgar Anderson, Geneticist to the Garden, spoke before the entomology section of the St. Louis Academy of Science, June 13, on "Mendelian Characters and Their Inheritance."

Mr. George H. Pring, Superintendent of the Garden, gave an illustrated talk on "Beautifying the Home Grounds," May 19, before the Fellowship Club of the Presbyterian Church, Edwardsville, Ill., and June 9, before the garden clubs of Herrin, Ill., and adjoining towns.

Mr. L. P. Jensen, Manager of the Arboretum, gave a talk to the members of the garden clubs of Sullivan and Gray Summit, Mo., May 31, when they were guests at the Arboretum, on "The Interest in Regional Planning by Garden Clubs"; and to the Garden Club of Rolla, Mo., at the Arboretum, June 10, on "The Missouri Botanical Garden Arboretum."

The second number of Volume XXIII of the ANNALS OF THE MISSOURI BOTANICAL GARDEN has been issued, with contents as follows: "Transitional Pittings in Tracheids of Psilotum," John Adam Moore and Henry N. Andrews, Jr.; "An Experimental Study of Hybridization in the Genus Apocynum," Edgar Anderson; "Studies in the Apocynaceae. IV. The American Genera of Echitoideae" (Concluded), Robert E. Woodson, Jr.

Recent visitors to the Garden include Dr. Milton Hopkins, of the Department of Botany, University of Oklahoma, Norman; Dr. Erzsébet Kol, Professor of Botany, University of Szeged, Hungary, who is studying in this country as Crusade Fellow, American Association of University Women; Dr. Thomas W. Whitaker, Associate Geneticist, U. S. San Diego Acclimitization Gardens, Torrey Pines, La Jolla, California.

STATISTICAL INFORMATION FOR MAY, 1936

GARDEN ATTENDANCE:	
Total number of visitors	43,844
LIBRARY ACCESSIONS:	
Total number of books and pamphlets bought	31
Total number of books and pamphlets donated	72
PLANT ACCESSIONS:	
Total number of plants and seed packets received as gifts	310
HERBARIUM ACCESSIONS:	
By Purchase—	
British Museum of Natural History—Photograph of *Lithospermum Drummondii* Lehm.	1
Gressitt, J. L.—Plants of Hainan Island, China	400
Redinger, K.—Zahlbruckner and Redinger, "Lichenes rariores exsiccati," Nos. 361-385, 61b	26
By Gift—	
Barkley, F. A.—Herbarium specimens of Illinois and Missouri plants	6
Barkley, F. A.—Paleobotanical specimens from Illinois	12
Carr, Mrs. G. Maddock—Herbarium of the late Waldemar Stertzing	259
Demaree, Delzie—Plant from Oklahoma	1
Ferguson, Noel M.—Specimen of *Hyoscyamus* from horticulture	1
Guthrie, C. G.—Plants of Missouri	6
Henry, Mary G.—*Aquilegia brevistyla* Hook. from British Columbia	1
Kellogg, John—*Sherardia arvensis* L. from Missouri	1
Miller, Sarah—*Lithospermum linearifolium* Goldie from Missouri	1
Reed, H. Earl—*Ribes sanguineum* Pursh from Washington	1
Rickett, H. W.—*Ranunculus bulbosus* L. from Missouri	1
Tuttle, Mrs. George M.—Plants of Missouri	3
von Schrenk, Hermann—*Taxodium mucronatum* Ten. from Guatemala	1
Williams, Louis O.—Plants of Colorado	5
Woodson, R. E., Jr.—Plants of Central America	2
By Exchange—	
Gilbert, F. A.—Plants of West Virginia	100
Hapeman, H.—Plants of Nebraska, Colorado, etc.	150
By Transfer—	
Anderson, E.—Plants of horticulture	3
Beilmann, A. P.—*Maclura pomifera* (Raf.) Schneid. from horticulture	1
Cutak, L.—*Piper* sp. from horticulture	1
Lodewyks, Maude C.—*Lonicera sempervirens* and *L. dioica* L. from horticulture	2
Moore, George T.—*Vesicularia vesicularis* Broth. from horticulture	1
By Field Work—	
Anderson, E. and L. Hubricht—Plants of Louisiana and Texas	9
Total	995

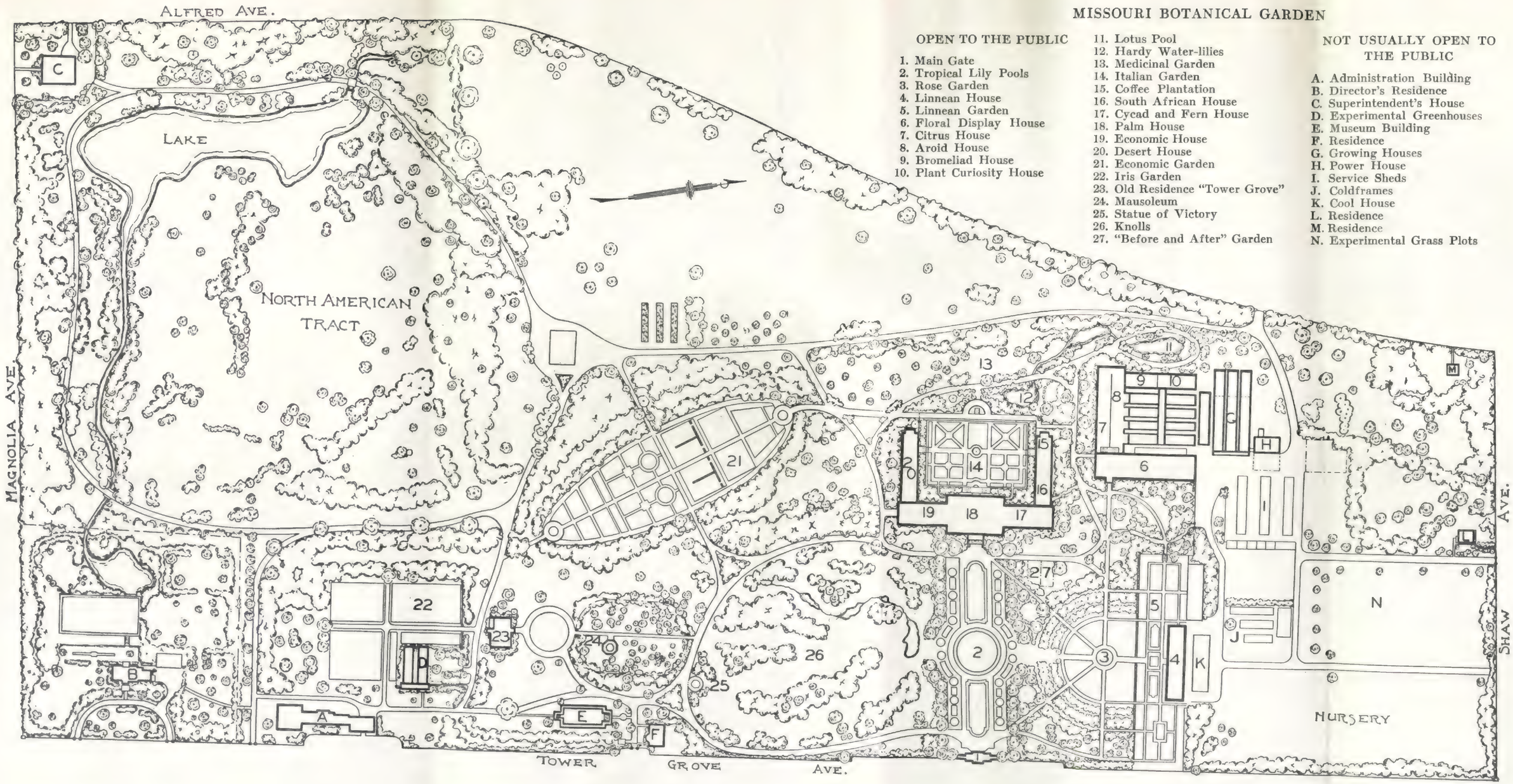
SOME FACTS ABOUT THE GARDEN

The Missouri Botanical Garden was opened to the public by Mr. Henry Shaw about 1860. From that date to the death of Mr. Shaw, in 1889, the Garden was maintained under the personal direction of its founder, and while virtually a private garden it was, except at certain stated times, always open to the public. Although popularly known as "Shaw's Garden" the name Missouri Botanical Garden was designated by Mr. Shaw as its official title and in his will or in any of his writings he specifically referred to it as the "Missouri Botanical Garden." By a provision of Mr. Shaw's will the Garden passed at his death into the hands of a Board of Trustees. The original members of the Board were designated in the will, and the Board so constituted, exclusive of certain ex-officio members, is self-perpetuating. By a further provision of the will, the immediate direction of the Garden is vested in a Director, appointed by the Board of Trustees. The Garden receives no income from city or state, but is supported entirely from funds left by the founder.

The city Garden comprises 75 acres, where about 12,000 species of plants are growing. There is now in process of development a tract of land of over 1,600 acres outside the city limits which is to be devoted to (1) the propagation and growing of plants, trees, and shrubs, designed for showing either indoors or outside, at the city Garden, thus avoiding the existing difficulties of growing plants in the city atmosphere; (2) gradually establishing an arboretum as well as holding a certain area as a forest reservation, with the idea that possibly at some future time this may become the new botanical garden.

The Garden is open to the public every day in the year, except New Year's Day and Christmas—week days from 8:00 a. m. until sunset; Sundays from 10:00 a. m. until sunset.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Place, on the Sarah car line (No. 42). Transfer south from all intersecting lines.



MISSOURI BOTANICAL GARDEN

OPEN TO THE PUBLIC

1. Main Gate
2. Tropical Lily Pools
3. Rose Garden
4. Linnean House
5. Linnean Garden
6. Floral Display House
7. Citrus House
8. Aroid House
9. Bromeliad House
10. Plant Curiosity House
11. Lotus Pool
12. Hardy Water-lilies
13. Medicinal Garden
14. Italian Garden
15. Coffee Plantation
16. South African House
17. Cycad and Fern House
18. Palm House
19. Economic House
20. Desert House
21. Economic Garden
22. Iris Garden
23. Old Residence "Tower Grove"
24. Mausoleum
25. Statue of Victory
26. Knolls
27. "Before and After" Garden

NOT USUALLY OPEN TO THE PUBLIC

A. Administration Building
B. Director's Residence
C. Superintendent's House
D. Experimental Greenhouses
E. Museum Building
F. Residence
G. Growing Houses
H. Power House
I. Service Sheds
J. Coldframes
K. Cool House
L. Residence
M. Residence
N. Experimental Grass Plots

OF

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MISSOURI BOTANICAL GARDEN BULLETIN

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CONTENTS

	Page
Drought and Heat Damage at the Missouri Botanical Garden Arboretum	163
Notes	179
Statistical Information	181

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Missouri Botanical Garden Bulletin

Vol. XXIV SEPTEMBER, 1936 No. 7

DROUGHT AND HEAT DAMAGE AT THE MISSOURI BOTANICAL GARDEN ARBORETUM

In the May BULLETIN for this year there was reported some of the damage done to trees and shrubs by the most serious winter ever experienced in the history of the Garden. It now becomes necessary to record in the same year the effect of the worst drought and the most protracted heat for this region of which the Weather Bureau has a record. With fifty-one days in July and August when the thermometer registered 90° or over and thirty-four days when the temperature reached 100° or more, and with a precipitation from January to September of exactly one-half normal, it would be no exaggeration to say that the trying conditions of the past season have scarcely been surpassed.

DAMAGE TO FOREST TREES AT THE ARBORETUM

During the spring and summer of 1936 the Missouri Botanical Garden Arboretum at Gray Summit has been in the edge of an area of severe drought. Although only thirty-five miles from St. Louis, it was consistently drier in the spring and early summer than in the city and drought damage has been correspondingly greater. Unfortunately no official records are available, but from May 1 to August 1 sunny weather was practically continuous and the rainfall during that period could not have totaled much over an inch. Moreover, the region was already seriously affected before it was hit by the virulent heat-waves of July. Pastures were brown and dry by the end of June, and in the fields the

leaves of young corn were so tightly rolled that they looked like some peculiar kind of gladiolus.

To the ordinary eye the trees still seemed fresh and green but to the trained plantsman there were all too many indications of water deficiency. Hackberry leaves hung in a listless fashion, redbud was dry and lifeless to the touch, oaks dropped a leaf or two, and sugar maples had an ominous yellow-brown tinge on their upper branches. One or two showers brought partial relief, but in mid-July came real heat-waves with temperatures of well over a hundred degrees. The effect was dramatic. Within the space of a few days leaves withered and fell and whole hillsides turned yellow. Damage was not uniform throughout the area. Cornfields would fire in one creek bottom but stay green in the next. Forests in deep clay soil showed little or no injury, while on rocky, southern slopes nearly every tree was badly affected.

These extreme differences between sites make it difficult to give a concise but comprehensive report on drought damage to the various forest trees. To present all the facts one would need to describe the whole region. The main points, however, can be included in a description of two distinctive areas, (1) the limestone glades, and (2) the oak-hickory woods.

Limestone glades are an interesting and characteristic feature of the central Ozarks. They are small areas, often only an acre or so in size, with a peculiar vegetation something like a desert and something like a rock-garden. Trees are small and widely spaced so that a glade presents an open, park-like appearance. Red cedars are by far the commonest species, but a number of other small trees are to be found; chittim-wood, blue ash, chinquapin oak, and the dwarf hackberry are the most characteristic. The soil cover in such areas is thin or lacking altogether, and the open spaces between the trees are a sort of natural rock-garden in which flourish such interesting plants as the purple cone-flower *(Echinacea purpurea)*, the prickly pear cactus *(Opuntia Rafinesquii)*, the wild petunia *(Ruellia carolinensis)*, and the leather flower *(Clematis Fremontii)*.

The Arboretum includes several of these characteristic glades in the area which has been set aside as a wild-flower reservation. Since they are the driest and rockiest part of the property they

have been most seriously affected by the drought. The following lists record the injury to trees and shrubs growing on the glades or around their edges. It was made during the last week in July and represents damage which was apparent at that time. It is probable that a careful inspection of these same trees during the next twelve months would show further effects of the drought, as yet unrevealed.

Acer saccharum Marsh. Sugar maple.
Leaves brown and dry, entire tree affected or only the uppermost branches, young trees killed to the ground.

Bumelia lanuginosa (Michx.) Pers. Chittim-wood.
No apparent injury.

Celtis occidentalis L. var. *crassifolia* (Lam.) Gray. Large-leaved hackberry.
Leaves dry and partially fallen or tree entirely defoliated and twigs dying.

Celtis pumila Pursh. Dwarf hackberry.
Leaves slightly yellowed.

Cercis canadensis L. Redbud.
Entirely defoliated, twigs dying.

Diospyros virginiana L. Persimmon.
Slightly defoliated, leaves somewhat wilted.

Fraxinus americana L. White ash.
Partially to completely defoliated.

Fraxinus quadrangulata Michx. Blue ash.
Leaves wilted, yellow, and slightly browned.

Juglans nigra L. Black walnut.
Entirely defoliated.

Juniperus virginiana L. Red cedar.
No apparent injury.

Quercus marilandica Muench. Black Jack oak.
No apparent injury or leaves slightly browned.

Quercus Muhlenbergii Engelm. Chinquapin oak.
Partially or completely defoliated.

Quercus stellata Wang. Post oak.
Partly defoliated and leaves yellow.

Rhus glabra L. Smooth sumach.
Leaves wilted, yellow, a little browned.

Symphoricarpos orbiculatus Moench. Coralberry, Buck brush.
Killed to the ground.

Those familiar with the limestone glades of the Ozarks will note that the above list includes a number of species such as the large-leaved hackberry which are not at all characteristic of most

glades. This is due to the recent history of the Arboretum. At the time the Missouri Botanical Garden bought the property these glades had been heavily grazed for a period of years and the original flora had become very much depleted. As soon as stock was kept off the area the plant cover increased rapidly. Some of the newcomers which rushed in were not well adapted to the glades and are now being eliminated. The chief effect of this summer's drought will be to leave the characteristic glade species more firmly entrenched there. Invaders from the surrounding woodlands will now find it difficult to enter, even during a series of wet years.

The other area in which detailed records were made is a second-growth wood-lot. It is fairly typical of the upland oak-hickory forests throughout central Missouri. The soil is a heavy, red clay which is slow to absorb moisture but equally slow to lose it. Though the trees were growing along a low ridge which sloped toward the south, few of them were conspicuously defoliated or discolored.

Acer saccharum Marsh. Sugar maple.
Leaves yellowing slightly.
Cornus asperifolia Michx. Rough-leaved dogwood.
Leaves wilting badly.
Cornus florida L. Flowering dogwood.
Leaves badly browned.
Quercus alba L. White oak.
No apparent injury or leaves slightly yellow.
Rhamnus caroliniana Walt. Indian cherry.
Leaves wilting badly.
Rhus glabra L. Smooth sumach.
Leaves wilting.
Ulmus americana L. American elm.
Slightly defoliated.
Ulmus fulva Michx. Slippery elm.
Leaves yellowing.

NO APPARENT INJURY

Diospyros virginiana L. Persimmon.
Fraxinus americana L. White ash.
Juglans nigra L. Black walnut.
Juniperus virginiana L. Red cedar.
Quercus borealis Michx. f. var. *maxima* Ashe. Red oak.
Quercus coccinea Muench. Scarlet oak.
Quercus imbricaria Michx. Shingle oak.
Quercus Muhlenbergii Engelm. Chinquapin oak.

Quercus stellata Wang. Post oak.
Quercus velutina Lam. Black oak.
Symphoricarpos orbiculatus Moench. Coralberry, Buck brush.

In view of the ultimate development of the Arboretum as a forest and wild-flower reservation the damage to the redbud is the most serious yet apparent. This cannot be blamed entirely upon the drought, for many of these trees were injured in last winter's severe cold and went into the summer in a very weakened condition. Between the two, however, the redbud has suffered, and it is difficult today to find a really healthy specimen on any part of the property. Even in sheltered valleys the majority of the trees show dead branches and most of them seem to be badly weakened. In the past the redbud has been one of our most decorative displays. Its brilliant wine-purple flowers are conspicuous while still in the bud and color the hillsides for at least a fortnight every spring. If the damage is as severe and as widespread as it seems to be, this display will not be back to normal for at least several years.

Severe damage to the flowering dogwood seems to be limited to those exposed to strong sunlight, but every tree shows at least a little wilting. It is quite possible that this species is even more badly injured than is apparent.

From a scientific standpoint one of the most interesting features of the drought is the difference in the behavior of various species. Not only is there tremendous variation in drought resistance, but those species which are affected show the effect in different ways. Sugar maples seem to be scorched by the sun. Usually only the exposed branches wither and turn brown but hang on to the twig. Sycamores drop their leaves and no particular part of the tree seems more affected than another. The leaves of the slippery elm turn yellow-green but persist on the tree. The American elm is most severely affected on the lower and most shaded twigs, where the leaves wither and dry, ultimately falling, and then the damage travels up into the higher branches. The sumachs wilt at the first approach of drought but show no further injury. The leaves of the papaw hang almost straight downward, but the leaflets of the Kentucky coffee-tree twist fantastically under-side around and stand edgewise to the light. One of the most inter-

esting contrasts is that between the white ash and the blue ash, both of which are found on or near the driest glades. The leaflets of the blue ash rumple as they wither and become a peculiar, yellowish gray-green. If they blacken it is only in small spots and they do not fall from the tree. The white ash shows no damage at first. The leaflets remain bright green and unwithered, though a few may turn black in large patches. Then with almost no warning they fall, in a day or two leaving the tree curiously bedecked with the shiny, yellow midribs. These ultimately drop and the tree is as leafless as if winter had set in. It is an interesting sight to see these closely related trees side by side on glade after glade, the white ashes either bare or partly defoliated, the blue ashes with their dry, crumpled, yellow-gray leaves.

Two of the species on the glades merit a trial as garden subjects, chittim-wood *(Bumelia lanuginosa)* and the dwarf hackberry *(Celtis pumila)*. They are so thoroughly drought-resistant and so picturesque that it would be worth while finding out if they have other necessary characteristics of a good garden tree. Are they easy to propagate; are they tolerant of a wide variety of soils; will they flourish under city conditions? The Garden will be very interested to hear from anyone who has tried out either of these species.

Chittim-wood will be a new name to all except a very few naturalists. It is surprising that a tree can be as common as it is in the region about St. Louis and still remain unknown and even unheard-of to the general public. To be sure it has no conspicuous flowers or fruit and its leaves are smallish and simply shaped. But it is a common tree on rocky hillsides and in worn-out pastures, and any one who has ever motored through the country about St. Louis must have seen hundreds of specimens along the roadside. The shape is particularly distinctive. The slender branches grow slowly and seldom fork, producing a few wand-like boughs which are closely set with leathery leaves, shiny green above and more or less rusty-brown beneath. The tree grows very slowly; on old specimens the trunk is seldom more than a foot in diameter. The branches twist irregularly, giving the whole tree, as seen in silhouette, a picturesque, unsymmetrical outline which reminds one of a Japanese painting. One might per-

haps compare it to a small-leaved and contorted pear tree. A closer examination will show an occasional thorn along the branches and reveal the small, greenish-yellow flowers which are hidden among the leaves in mid-summer. The flowers are followed by small, inky-black fruits which persist during the fall and early winter. As a garden tree, the chittim-wood might be worth growing if only for the autumnal effect of its graceful little leaves which remain green until well into November, contrasting handsomely with the reds and browns of the other trees.

The dwarf hackberry *(Celtis pumila)* is also rather Japanesque in shape. Glade-grown specimens are usually under five feet in height and remind one of the dwarf-trees grown by Japanese gardeners. It would be an interesting experiment to attempt transplanting a nicely shaped dwarf hackberry into a large flower-pot or plant-tub and growing it as a dwarf-tree. In gardens, given good soil and plenty of room, it grows somewhat larger than on the glades but still remains a small tree. Like all hackberries it is very similar to its close relatives the elms, but is even finer-twigged and more graceful in shape. *Celtis pumila* seems to be more immune to the "witches brooms" which deform most hackberries. Its leaves, while thick and leathery, are graceful in outline and are smaller than those of other species. A few specimens in the Missouri Botanical Garden have given a good account of themselves under city conditions. All in all the dwarf hackberry is worthy of more extensive trial.

E. A.

TEMPERATURE AND MOISTURE DETERMINATIONS IN TREES

Previous issues of the Bulletin (November, 1934, March, 1935) have told how the health of a tree may be diagnosed by its temperature and the per cent of moisture in the trunk. Since the adaptability of the trees at the Arboretum seemed to depend in part at least upon the conditions of their individual locations, an effort was made to study as many of these species as possible, and from different habitats. Just as a doctor might take the temperature and pulse of a heat victim, so temperature and moisture determinations were made upon the Arboretum trees.

Either of two methods may be used to determine the moisture in a tree trunk. The entire tree can be cut down and certain sections taken to a laboratory for weighing and drying, or an increment borer may be used. The latter method is best suited for field work and is probably more accurate. The increment borer is a hollow-point augur which when turned into the tree extracts and preserves a core of wood. Immediately after withdrawal of the bit the core is placed in a numbered and tightly stoppered vial. Later these are weighed and then dried in an oven at 110° F. for at least twenty-four hours. After drying to a constant weight the percentage of moisture can easily be calculated. An objection to this method is the possible loss of water because of the heat generated when the tool is driven into the trunk.

The internal temperature of a tree trunk can be determined at the same time the increment borer is used. For this purpose an immersion thermometer will be found satisfactory, provided it has a bulb large enough to fit loosely in the hole made by the removal of the core. Some time must elapse (generally ten to twelve minutes) before the heat generated by the borer has been dissipated. After about twenty minutes the temperature will have become stationary and the reading thus obtained will compare favorably with more exact work. Generally whatever error occurs will remain constant throughout the day unless there is a definite change in the weather.

The first boring was taken from a chestnut oak and the second from the common juniper. Both of these grew halfway up a hill to the north of a spring, the hillside having a south and east exposure. The next two, a chittim-wood and a juniper, were selected from the driest area in the Arboretum, a cliff overlooking the river. Three more, an ash and two hickories, grew on a hilltop just south of the orchards. Here the soil is deeper and covered with turf except where shade and the litter of the forest floor make conditions impossible for grass. The last tree selected, a hard maple, grew on the edge of a glade. It is in such locations that the keenest competition exists between the established junipers and the encroaching deciduous species. The glades are almost without soil and consequently very little water is available. The following table shows the moisture present in the cores, as

well as the temperature of the trunks, at the time the boring was made:

Tree No.	Scientic name	Temper-ature	Per cent water	Condition	Location
I	*Quercus Muhlenbergii*	100° F.	Discarded	Wilting	Southeast-ern slope
II	*Juniperus communis*	89.6° F.	75	Normal	Southeast-ern slope
III	*Bumelia lanuginosa*	90.0° F.	73	Leaf tips slightly burned	Cliff-edge
IV-A	*Juniperus communis* (sap-wood only)	92.4° F.	54.7	Normal	Cliff-edge
IV-B	Same tree (heart- and sap-wood)	92.4° F.	42.0	Normal	Cliff-edge
V	*Fraxinus americana*	95.0° F.	42.6	60% defoliated	In deep soil
VI	*Carya ovata*	82.5° F.	48.8	Entirely normal	In deep soil
VII	*Carya ovalis odorata*	89.5° F.	55	Entirely normal	In deep soil
VIII	*Acer saccharum*	98.0° F.	38.5	Entirely burned	On glade

Unfortunately the vial containing the chestnut oak core was broken and only the temperature record is available. However, the reading (100° F.) would indicate that little water was left for transpiration purposes. The second tree, growing within ten yards of the oak, appeared normal and contained 75 per cent of moisture. It is especially interesting to compare No. II with IV-A and IV-B, all of which are junipers but growing in different locations. The first had an internal temperature of 89.6° F., and the second had one nearly three degrees higher. The sap-wood of the second specimen contained 54.7 per cent of moisture, while a core composed of both sap- and heart-wood (similar to No. II) contained 42 per cent, or one-third less than the more favorably located tree. The chittim-wood, No. III, growing within fifteen yards of the juniper, proved to have 73 per cent water,

a substantial reserve, although both trees have been impartially frozen in winter and burned in summer for many years. Of the subjects selected from an area more suitable for tree growth, only the American ash was seriously injured. It contained but 42.6 per cent of moisture with an internal temperature of 95° F. Within twenty yards were two hickories, both of which appeared normal. The first, a shag-bark, contained 48.8 per cent of water and had a temperature of 82.5° F. The other, a small pig-nut, contained more water (55 per cent) but had a higher temperature—89.5° F. Tree No. VIII, a hard maple, grew in an area unsuited for maples except in very wet years. As a result it was very badly burned, only 38.5 per cent of moisture remaining while the temperature was 98° F.

A. P. B.

DAMAGE TO PLANTATIONS

The nursery near the Robertsville Road was in a favorable location and suffered very little damage from the drought and heat. No watering was done here but the ground was constantly cultivated and the moisture preserved by a dust mulch. The following plants show the foliage slightly burned:

Aesculus glabra .....Ohio buckeye
Cornus florida .....Flowering dogwood
Syringa reflexa .....Nodding lilac
Syringa Wilsonii .....Wilson's lilac

In the nursery near the Administration Building, in spite of cultivation and repeated watering, the damage has been considerably greater.

Killed:
Acanthopanax pentaphylla
Cistus laurifolius .....Rock-rose
Ginkgo biloba .....Maidenhair tree
Halesia hispida .....Silver-bell
Ilex cornuta .....Japanese holly
Jasminum fruticans .....Jasmine
Juglans mandshurica .....Manchurian walnut
Philadelphus pubescens .....Mock-orange
Rhodotypos kerrioides
Sorbaria stellipila .....False spirea
Syringa villosa .....Lilac
Vaccinium vacillans .....Blueberry

Foliage injured:
Cornus florida .....Flowering dogwood (slightly)
Buxus sp. .....Boxwood (slightly)
Sorbus Aucuparia .....European mountain ash (severely)

Practically all seedlings from seeds sown last fall and spring in the seed-beds and frames have been killed. Seedlings of 1934-35 are mostly in good condition.

The following list shows the extent of injury to the conifers in the nursery:

Abies concolor	Colorado fir	Killed
Chamaecyparis Lawsoniana ..	Lawson's cypress	Killed
Picea Engelmanni	Engelmann spruce ..	Foliage badly burned
Picea glauca	White spruce	Badly burned
Taxus cuspidata	Japanese yew	Killed
Thuja	Arbor-vitae	All species, foliage burned
Tsuga canadensis	Hemlock	Foliage injured

The conifers in the pinetum have been regularly watered and very few have died. The following have foliage injured:

Larix decidua .....European larch
Picea excelsa .....Norway spruce
Picea pungens .....Colorado blue spruce
Thuja, all species .....Arbor-vitae

The orchards are in good condition, but all the Japanese cherries planted there last spring have died. *Betula alba* (white birch), *Pinus Strobus* (white pine), and *Pinus ponderosa* (western yellow pine), transplanted in the fall of 1935 and spring of 1936, were killed.

The plantation of rhododendrons and azaleas, in spite of heavy mulching and watering, has suffered greatly. Only *Rhododendron molle* is in fairly good condition. Most of the hybrid rhododendrons are dead.

L. P. J.

THE EFFECT OF HIGH TEMPERATURE ON ORCHIDS UNDER GLASS

With plants growing out of doors it is frequently difficult to determine whether damage is due to lack of moisture, to excessive heat, or to a combination of both. In the greenhouse where water

EFFECT OF EXTREME HEAT ON PLANTS

Cattleya labiata, showing flower buds blackened within their sheath

Anthurium Veitchii, with leaves burnt and dropping

may be applied as frequently and abundantly as needed, injury from drought can be eliminated, and in no place has the effect of high temperature been more clearly demonstrated than in the orchid houses at the Arboretum.

The extreme heat of the summer of 1934 damaged the orchids slightly, particularly those which normally grow at high elevations. This appeared chiefly as tip burn and an occasional blackening of buds of the Cattleyas and their hybrids, but enough plants flowered to form an exhibit during July and August. The heat of this summer, however, has caused considerable temporary damage to the orchids at the Arboretum as well as to the tropical plants in the city greenhouses. Orchids normally flowering in July and August, such as Cattleya, Laeliocattleya, Brassocattleya, and the East Indian species of Paphiopedilum, have not shown a single blossom. The buds of the slipper orchids and their hybrids were scorched, particularly *Paphiopedilum Holdenii, P. Maudiae, P.* "Olivia," *P.* "Argus," *P. superbiens,* and *P. tonsum.* The intense heat had even penetrated the double flower sheath of *Cattleya labiata,* and the young flower buds were blackened (pl. 40, fig. 1). However, the protective sheath itself was moist and perfectly normal.

Dendrobiums of the evergreen type, particularly *D. thyrsiflorum,* showed tip burn or defoliation. *D. Phalaenopsis* apparently was not affected and is now producing young flower shoots. *Dendrobium nobile* and hybrids seemed to withstand the high temperature. The new growth even exceeded that of the previous season but the leaves attached to the old growth soon yellowed and dropped. The wire supports around these plants became so hot that they burned the epidermis of the young growing shoot (pl. 41, fig. 2).

The botanical orchids, particularly those from Panama, plainly showed the effect of high temperature. (In the tropical station at Balboa, the average temperature reading is 70° to 90° F. throughout the year.) *Odontoglossum crispum* and hybrids died within three weeks. Repeated attempts, over a series of years, to grow Odontoglossum, Sophronitis, Masdevallia, Restrepia, Disa, etc., have resulted in failure.

The Vandeae, particularly such genera as Vanda, Aerides,

EFFECT OF EXTREME HEAT ON PLANTS

Above—*Trichopilia suavis*, leaves burnt, later dropping from pseudobulbs
Below—*Dendrobium nobile*, leaves burnt by wire support

Saccolabium, Sarcochilus, Angraecum, and hybrid Phalaenopsis appear normal at the present time. Cymbidiums show a decided yellow-green foliage and occasional tip burn, particularly the hybrids with *C. insigne* parentage. In the Paphiopedilum (Cypripedium) house the Himalayan plants *(P. insigne)* have yellow-green foliage, more marked than in 1934, and very few flowers.

The Cattleyas show a decided dislike for extremely high temperature. In *Cattleya Mossiae* the leaves have turned yellow-green, and there is a premature loss of back bulbs. *Cattleya Trianae* and *C. labiata,* which make their growth in summer, show weak growth, and the flower buds developing from the pseudobulb have decayed. It is too early to judge *C. Trianae,* since its buds normally develop later in the season. However, during 1934 only one flower formed to the bulb, the others being blind. The Cattleya hybrids have made normal growth, those with Brassocattleya parentage not being affected other than the young flower buds being blackened.

During the past two months temperatures in the orchid houses reached 115° F. despite heavy shade upon the roof glass and half the range being covered with slat roller-shades. To increase humidity all concrete benches are filled with eight inches of water, upon which wooden slat benches support the growing plants. Normally, watering in the morning and spraying in the afternoon is sufficient, with the constant evaporation from the water below, but during the high temperature and low humidity double the amount of spraying was necessary. Summer ventilation ordinarily means the opening of all doors and ventilators. During the past two months, however, in order to keep the hot dry air out and moist air within, in the morning all east side and top ventilators were closed and west ventilators were opened, while in the afternoon the north doors were opened and all south doors closed. At night, every available ventilator and door was opened to permit the cool (?) air of 90 degrees to enter.

ORCHIDS

Leaves burnt, later dropping from pseudobulb:

Acineta chrysantha
Bifrenaria Harrisoniae
Catasetum Oerstedii
Cirrhopetalum Thouarsii
Coelia Baueriana
Coelogyne barbata

Coelogyne cristata
Coelogyne Dayana
Coelogyne fimbriata
Coelogyne Massangeana
Coelogyne Parishii
Coelogyne pandurata
Coryanthes macrantha
Cycnoches Warscewiczii
Dendrobium cymbidoides
Dendrobium thyrsiflorum
Dendrobium uniflorum
Epidendrum fragrans
Epidendrum raniferum
Epidendrum vitellinum
Epidendrum Schlechterianum
Eria gigantea
Gomesa fragrans
Gomesa recurva
Gongora aromatica
Gongora Powellii
Laelia majalis
Lockhartia chiriquensis
Lockhartia pallida
Lycaste aromatica
Lycaste macrophylla
Lycaste Skinneri
Maxillaria crassifolia
Maxillaria luteo-alba
Miltonia candida
Miltonia Cogniauxiae
Miltonia flavescens
Miltonia Roezlii alba
Odontoglossum Cervantesii
Odontoglossum citrosmum
Odontoglossum maculatum
Odontoglossum nebulosum
Odontoglossum Powellii
Odontoglossum Rossii
Oncidium ampliatum
Oncidium cheirophorum
Oncidium ornithorynchum
Oncidium panamense
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Pholidota imbricata
Platyclinis filiformis
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Trichopilia Powellii
Trichopilia suavis

Leaf tips burnt:

Brassavola nodosa
Brassavola fragrans
Brassia brachiata
Brassia Gireoudeana
Brassia longissima
Brassia verrucosa
Bulbophyllum Careyanum
Bulbophyllum sp. (Panama)
Cymbidium (hybrids and species)
Cyrtopodium punctatum
Dendrobium chrysotoxum
Dendrobium Dearei
Dendrobium undulatum
Dichaea panamensis
Epidendrum amandum
Epidendrum anceps
Ipsea speciosa
Lycaste brevispatha
Lycaste cruenta
Lycaste macrophylla
Oncidium sphacelatum
Ornithidium Sophronitis
Peristeria elata
Phaius grandifolius
Phaius Tankervillii
Phragmopedilum (hybrids)
Scaphyglottis albida
Tainia penangiana
Tainia viridi-fusca
Xylobium hyacinthina
Zygopetalum Mackaii

Plants killed:

Odontioda Lambeauiana
Odontoglossum "Fabia"
Odontoglossum "Gladiator"
Odontoglossum "St. Anstell"

Flower buds blackened within their sheath:

Brassocattleya (hybrids) Laeliocattleya (hybrids)
Cattleya labiata

Buds burnt:

Paphiopedilum (hybrids) Phragmopedilum (hybrids)

Pseudo-bulbs burnt by wire supports:

Dendrobium nobile hybrids

OTHER PLANTS IN ORCHID HOUSE

Leaves burnt:

Anthurium Andraeanum (hybrids) *Anthurium Veitchii*
Anthurium Scherzerianum *Anthurium Warocqueanum*

Young leaves burnt:

Adiantum cuneatum *Cibotium Schiedei*

BROMELIADS BURNT IN GREENHOUSES AT GARDEN

Aechmea fulgens discolor *Billbergia rosea*
Aechmea Weilbachii

G. H. P.

NOTES

As has been the custom for the past several years, a wreath of magnolia leaves and flowers from the Garden was placed on the tomb of Henry Shaw, on August 25, the anniversary of his death.

Dr. Robert E. Woodson, Jr., Research Assistant to the Garden, has a paper in *Sunyatensia* (**3**: 65-105), on "Studies in the Apocynaceae. V—A Revision of the Asiatic Species of Trachelospermum Lem."

Mr. G. H. Pring, Superintendent of the Garden, acted as judge at the International Horticultural Exposition, at Chicago, September 12; and in the evening he gave an illustrated lecture there on "Plant Exploration in Central and South America."

Dr. George T. Moore, Director of the Garden, acted as toastmaster at the Fiftieth Anniversary Banquet of the St. Louis Florist Club, at the Hotel Jefferson, June 25; and Mr. George H. Pring, Superintendent of the Garden, gave an after-dinner talk at the banquet entitled "The Plant Speaks."

The third number of Vol. XXIII of the ANNALS OF THE MISSOURI BOTANICAL GARDEN was issued in September, with the following contents: "A New Sequoioxylon from Florissant, Colorado," Henry N. Andrews, Jr.; "Field and Herbarium Studies. IV," Louis O. Williams; "The Species Problem in Iris," Edgar Anderson; and "Hybridization in American Tradescantias." Edgar Anderson.

The joint committee on Roadside Development of the American Association of State Highway Officials and the Highway Research Board convening at the Hotel Statler, July 6-11, visited the Arboretum, July 7, where Mr. L. P. Jensen, Manager of the Arboretum, gave a talk on "The Missouri Botanical Garden Arboretum." On July 8 they visited the City Garden, and Mr. A. P. Beilmann, Arboriculturist to the Garden, spoke on "Fertilizing of Shade Trees."

Visitors to the Garden library and herbarium during the summer months include Mr. Hurst T. John, Landscape Architect. Stephens College, Columbia, Mo.; Dr. L. O. Gaiser, McMaster University, Hamilton, Ontario, Canada; Miss P. Snure, Teaching Assistant in Botany, University of Wisconsin, Madison, Wis.; Mr. John Marr, Teaching Assistant in Botany, Northwestern University, Evanston, Ill.; Mr. William O. Mitchell, Superintendent of Horticulture and Landscape Construction, Cincinnati, Ohio: Dr. Ernest Sears and Dr. Joseph O'Mara, of the Missouri Agricultural Experiment Station, Columbia, Mo.; Mr. H. W. Alberts, Associate Agronomist Soil Conservation Service, Edwardsville, Ill.; Dr. R. A. Fisher, of the Galton Laboratory, University of London, England; Dr. Fr. Verdoorn, Editor, Annales Bryologici and Chronica Botanica, Utrecht, Holland.

The following extract of an announcement received from E. N. Munns, of the Department of Agriculture, is published because of its timely interest and also to give the BULLETIN readers the opportunity to cooperate with Mr. Munns in the survey of the drought areas:

A STUDY OF THE EFFECT OF DROUGHT ON TREES

"The 1936 drought is one of the most serious and widespread the nation has ever experienced. . . . In times of severe drought, forest

plantations suffer severely especially those composed of species not native to the locality or those badly abused as by grazing. In addition many native species that have been slowly invading drier sites or localities may be eliminated over large areas.

"The Forest Service is undertaking the collection of data on the drought damage. . . . Consequently, anyone with observations on species behavior should communicate them to the Division of Silvics of the Forest Service at Washington, D. C. Data are desired especially on such features as the nature, extent, and character of the damage, the relative resistance of trees growing on different sites, the comparative ability of native and exotic trees to withstand drought and the nature and extent of the damage to stands or to shade or ornamental trees, shrubs, etc. A questionnaire covering these points has been drawn up to aid observers in reporting the effects of the current drought."

STATISTICAL INFORMATION FOR JUNE-AUGUST, 1936

GARDEN ATTENDANCE:

Total number of visitors in June	26,697
Total number of visitors in July	22,125
Total number of visitors in August	32,570

PLANT ACCESSIONS:

Total number of plants and packets of seeds donated in June	306
Total number of plants and packets of seeds donated in July	402
Total number of packets of seeds donated in August	14

LIBRARY ACCESSIONS:

Total number of books and pamphlets bought in June	14
Total number of books and pamphlets donated in June	218
Total number of books and pamphlets bought in July	10
Total number of books and pamphlets donated in July	72
Total number of books and pamphlets bought in August	42
Total number of books and pamphlets donated in August	141

HERBARIUM ACCESSIONS:

JUNE

By Purchase—

Bush, B. F.—Plants of Kansas and Missouri	200
Williams, Louis O.—Plants of the Northern Rocky Mts.	2,000

By Gift—

Aldridge, Ada F.—*Gilia aggregata* Spreng. from Arkansas	1
Anderson, E.—*Tradescantia occidentalis* (Britt.) Smith var. *typica* Anderson & Woodson from Oklahoma	1
Barkley, F. A.—Plants of Missouri	36
Bettis, Mrs. James R.—Plants of Missouri	2
de Gruchy, James—Plants of Oklahoma	58
Demaree, Delzie—Plants of Oklahoma and Arkansas	19

Hayward, Wyndham—*Nothoscordum bivalve* (L.) Britton from Florida	1
Larisey, Miss Maxine—Plants of Missouri	4
Little, Elbert L.—Plants of New Mexico	2
Lodewyks, Maude C.—Plants of Missouri	2
Moore, John Adam—Plants of Missouri, Wisconsin, etc.	95
Teas, Edward—*Ardisia japonica* (Thunb.) Blume from Louisiana	1
U. S. Department of the Interior, National Park Service—Plants of the Platt National Park	150
von Schrenk, Hermann—Plant from Spain	1
Williams, Louis O.—Plants of northwestern United States and adjacent Canada	52
By Exchange—	
Arnold Arboretum—Plants of Guatemala	12
New York Botanical Garden by J. K. Small—Ferns of Florida	17
Colorado Seminary, University of Denver, by Miss Henrietta L. Zobel—Plants of Colorado	211
By Transfer—	
Anderson, E.—*Tradescantia virginiana* L. from Iowa	4
Anderson, E.—Plants of Texas	3
By Field Work—	
Anderson, E.—Plants of Missouri, Arkansas, Louisiana, Texas and Oklahoma	20
Total	2,892

JULY

By Purchase—	
British Museum of Natural History—Photograph of *Lithospermum corymbosum* Lehm	1
Bush, B. F.—Plants of Missouri and Arkansas	413
Degener, Otto—Plants of Hawaii	58
Erichsen, C. F. E.—"Deutchse Lichenen," Halbzenturie 7 & 8, nos. 301-400 inclusive	100
Weigel, Theodor Oswald—Weese, "Fumycetes selecti," Fasc. XXX, nos. 726-750 inclusive	25
By Gift—	
Brown, C. A.—Plants of Louisiana	14
Crookshanks, D. R.—Plants of Missouri	36
Ledman, O. S.—Plants of Horticulture	3
Osborn, Ben—Plants of Nebraska	170
Wild, C. M.—*Oenothera missouriensis* Sims from Missouri	1
By Exchange—	
Botanical Institute—Bacou, U. R. S. S.	150
Carnegie Museum, Pittsburgh, by E. H. Graham—Plants of Utah	523
Demaree, Delzie—Plants of Oklahoma	26
Krukoff, B. A.—Plants of Sumatra	366

New York Botanical Garden by J. K. Small—Ferns of Florida	35
United States National Museum—Plants of Ecuador and Colombia	26
University of Oklahoma—Plants of Oklahoma	100
By Transfer—	
Cutak, J.—Plant of Horticulture	1
Fairburn, D.—*Reseda alba* L. from Horticulture	1
Total	2,049

AUGUST

By Purchase—	
Harper, Roland M.—Plants of Alabama and Louisiana	10
Verdoorn, Fr.—"Musci Selectae et Criticae," Series IV, nos. 151-200 inclusive	50
Verdoorn, Fr.—"Hepaticae Selectae et Criticae," Series X, nos. 451-500 inclusive	50
By Gift—	
Barkley, F. A.—Plants of Illinois, Missouri, and Mexico	14
Beal, J. M.—*Allium* from Horticulture	7
Johnson, Rufus D.—*Coryphantha arizonica* (Engelm.) Britt. & Rose from Arizona	1
von Schrenk, Hermann—Plants of Texas	121
Wolfe, I. J.—*Rhamnus caroliniana* Walt. from Tennessee	2
By Exchange—	
Gray Herbarium, Harvard University—Plants of southeastern Virginia	37
Total	292

SOME FACTS ABOUT THE GARDEN

The Missouri Botanical Garden was opened to the public by Mr. Henry Shaw about 1860. From that date to the death of Mr. Shaw, in 1889, the Garden was maintained under the personal direction of its founder, and while virtually a private garden it was, except at certain stated times, always open to the public. Although popularly known as "Shaw's Garden" the name Missouri Botanical Garden was designated by Mr. Shaw as its official title and in his will or in any of his writings he specifically referred to it as the "Missouri Botanical Garden." By a provision of Mr. Shaw's will the Garden passed at his death into the hands of a Board of Trustees. The original members of the Board were designated in the will, and the Board so constituted, exclusive of certain ex-officio members, is self-perpetuating. By a further provision of the will, the immediate direction of the Garden is vested in a Director, appointed by the Board of Trustees. The Garden receives no income from city or state, but is supported entirely from funds left by the founder.

The city Garden comprises 75 acres, where about 12,000 species of plants are growing. There is now in process of development a tract of land of over 1,600 acres outside the city limits which is to be devoted to (1) the propagation and growing of plants, trees, and shrubs, designed for showing either indoors or outside, at the city Garden, thus avoiding the existing difficulties of growing plants in the city atmosphere; (2) gradually establishing an arboretum as well as holding a certain area as a forest reservation, with the idea that possibly at some future time this may become the new botanical garden.

The Garden is open to the public every day in the year, except New Year's Day and Christmas—week days from 8:00 a. m. until sunset; Sundays from 10:00 a. m. until sunset.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Place, on the Sarah car line (No. 42). Transfer south from all intersecting lines.

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MISSOURI BOTANICAL GARDEN BULLETIN

Vol. XXIV OCTOBER, 1936 No. 8

CONTENTS

	Page
Lycoris squamigera	185
Ground Covers for St. Louis Gardens	186
Free-Blooming Cacti for the Amateur	194
Notes	197
Statistical Information	199

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LYCORIS SQUAMIGERA

Missouri Botanical Garden Bulletin

Vol. XXIV OCTOBER, 1936 No. 8

LYCORIS SQUAMIGERA

One of the most interesting summer-blooming bulbs is the hardy amaryllis. It is called the hardy amaryllis because the flowers resemble the common amaryllis (Hippeastrum) and it is hardy in any winter without protection. The color of the flowers is a delicate lavender-pink. The strap-shaped leaves appear early in spring at the same time as the narcissus, which it resembles, and in late June or early July completely disappear. This change comes about so gradually that any one, growing this bulbous plant for the first time, will have forgotten all about it after the foliage has disappeared. The great surprise comes in August, when the flower stalks push through the soil and within a few days will have attained a height of about two feet, surmounted by an umbel of a dozen or more lily-shaped flowers.

There are very few plants that send up a flower-stalk without any accompanying foliage, and on that account some consideration should be given to the proper location of the bulbs. They are best set between some low-growing perennials whose foliage will cover the bare stems. To name a few combinations—this amaryllis looks well planted between clumps of the Chinese forget-me-not, dropwort, and other perennials with a compact habit of growth, or, it may be planted between dwarf peonies, dictamnus, or hostas. The bulbs should always be grown in a location where they will not be disturbed by any gardening operations. It is most disconcerting when preparing the soil for the planting of bulbs or perennials to run the spading fork through one of these bulbs, the exact location of which has been forgotten. The bulbs increase slowly and should not be disturbed for from

three to five years, when they may be lifted and divided. If they are to be lifted in the fall, it is well to place a label or stick next to each flower stalk, in order that the location of the bulbs may not be lost. After about five years one bulb will have divided into two or three larger ones. It is this slow increase that accounts for the high price of this hardy amaryllis. Bulbs are usually listed at one dollar apiece and the larger ones at a dollar and a half. However, this is one bulb that will not fail to grow, unlike some of the lily bulbs which never show above ground after being planted or disappear the second year.

The bulbs may be planted in the spring or the fall and should be planted at least eight inches deep. A cushion of sand under each bulb is a good garden practice but is not essential in a well-drained location. If this amaryllis is planted in part shade, the flowers will last longer, as it is usually quite hot in August. In 1935 the blooming period in St. Louis extended from August 12 to 25 and in 1936 from August 5 to 15.

Lycoris squamigera is the correct botanical name for this hardy amaryllis but it is usually listed in the catalogues as *Amaryllis Hallii*. Occasionally it is included in the fall bulb catalogues, but more generally it is listed in the spring catalogues, with the summer-flowering bulbs. P. A. K.

GROUND COVERS FOR ST. LOUIS GARDENS

When Henry Shaw, in 1840, purchased the prairie farm which has since become the Missouri Botanical Garden, there was then on the property a small grove to which he became greatly attached. He fenced it in and built his summer home near it. He even gave it public recognition by naming the estate "Tower Grove" in allusion to it and to the commanding square tower of what we today call "The Old Residence." When an old man he built his mausoleum in the grove and it is there that he was buried. As a grove it is still in existence though practically all of the original trees have disappeared. About six years ago the increasing shade made the care of the area a very real problem and a concerted attempt was made to find ground covers which would withstand the shade and the city conditions and yet be attractive throughout the year. Several promising plants have been found

VIEW IN MAUSOLEUM GROVE

and the mausoleum grove now serves a double purpose. It is a test plot where plants for shady city gardens may be given a thorough trial. It is as well a quiet and dignified memorial to Mr. Shaw, a most appropriate one for an Englishman who loved plants and gardens. With every year it takes on more the aspect of a park on an English estate. Particularly on a hazy afternoon late in the fall, when the old iron fence with its massive stone posts stands out between the bare branches of the shrubbery and the ivies are still fresh and green, it is hard to believe that one is in St. Louis and not in England.

The search for better ground covers still continues but at least a preliminary report can now be made on what to plant and how to plant it, and how to care for it afterwards. In spite of last winter's severe cold and this summer's phenomenal drought a number of the ground covers came through very well indeed. One could scarcely ask for a more severe test than they have undergone in the last ten months.

Baltic Ivy (*Hedera helix* var. *baltica*).—Where it can be grown, the common European ivy, or "English Ivy" as it is usually known in America, is the most satisfactory ground cover. It is low-growing, evergreen, relatively immune to insect attacks, shade-tolerant, yet not averse to partial sun. Unfortunately, most of the English ivy on the market winterkills in St. Louis. Some strains of it are killed back every winter, others behave satisfactorily in an average winter but are badly damaged during the most severe ones. Of all the varieties which have been extensively tried at the Missouri Botanical Garden, only one has been completely reliable. This is the Baltic ivy or "Russian Ivy," a variety of the European ivy collected near the coldest edge of its range. Nearly indistinguishable from ordinary ivy in general appearance, its leaves are somewhat smaller on the average, although ordinarily a very few will be quite large, giving it a rather shaggy appearance when grown as a vine. Two characteristics, however, make it a more valuable ground cover than the other varieties which have been tried out here. It is much hardier and its habit of growth is somewhat different. It spreads more rapidly and clings closer to the ground. Even before last winter's phenomenal cold, it seemed to be one of the best ground covers in the collection. In the light of that severe

A STUDY IN TEXTURES

Above—Gill-over-the-ground; center—Lily-turf; below—Baltic ivy. (All × 1/5.)

test it is clearly in a class by itself. Some varieties which had previously seemed promising died out altogether, others were killed back or had their leaves badly burned. The Baltic ivy, though not in a favored location, came through last winter with only a little browning and very little real injury. A few of the other varieties were fairly satisfactory, particularly one which has apparently been used in the St. Louis region for some time and is known locally as "French Ivy." Its botanical name, in allusion to the gracefully lobed leaves, is *H. helix* var. *sagittifolia*. While not quite as hardy nor nearly as vigorous as the Baltic ivy its more delicate and uniform leafage and its more graceful habit of growth make it preferable in certain situations.

The selection of a vigorous, hardy variety is not the only reason for the thrifty appearance of the ivy in the mausoleum grounds. Equally important are the use of well-rooted cuttings, the proper preparation of the soil, and the care of the beds after planting out. Cuttings are taken in the fall and are rooted in flats of sand in a cool greenhouse. Where plenty of material is available each cutting should have two leaves, though most of the work at the Garden has been with single-joint cuttings in order to obtain the maximum increase. The cutting is buried to such a depth that the upper bud (in the axil of the leaf) will be just about even with the surface of the soil. The cuttings are left in the sand until thoroughly rooted, a process usually requiring about two months. They are then potted up and carried through the rest of the winter in two-inch pots and are ready to set out the following April.

The soil is carefully prepared before the ivy is planted. Were the labor then available it would be better to prepare the soil in the fall but for practical reasons the work in the mausoleum grounds has had to be done in the early spring. In the soil pits at the Garden, leaves are composted with sand until the whole forms a light friable mixture. This is spread over the ground to the depth of two inches and is well spaded in. The ivy plants are set out about a foot apart and are well-watered immediately. If the season is a dry one they are given thorough waterings at regular intervals throughout the first growing season, after which time they will require watering only in periods of severe and prolonged drought.

A simple sort of winter protection is given by scattering dry freshly gathered leaves loosely over the beds. One should put on just enough leaves so that the ivy leaves themselves will poke through here and there. In the spring the surplus leaves are removed by a very light raking over the surface. About half of the leaves will have jammed down in among the vines and are left as a top dressing. This is supplemented after the raking with a light top dressing of well-composted leaves and with a similar one in summer during dry years.

The home gardener who has no greenhouse would find it easy to make his ivy cuttings in early September, leaving them in a cold-frame over the winter, where they can be lightly shaded from the sun.

More than one reader, at the recital of the care and attention which may profitably be given a bed of ivy, will probably feel that he would rather try something else. It should be remembered, however, that the ivy is being used as a ground cover, to replace grass, and that once the ivy is established the total time expended during a year will be much less than would have been spent upon an average lawn of that size. The ivy, moreover, can be made to flourish in situations where grass would be unsatisfactory.

Pachysandra.—On the Atlantic Coast this small-leaved shrubby vine has made a deservedly great reputation as a beautiful ground cover for shade and semi-shade. It is smaller-leaved than ivy, less rampant in growth, and more aristocratic in its general appearance. It is, however, *not to be recommended for St. Louis,* nor for many places in the Middle West. More than one eastern landscape architect has been unsuccessful in attempting to use it in St. Louis as it admittedly can be used in Philadelphia or on Long Island. It does not like our soil; it does not like our climate; it is expensive to buy and difficult to maintain in a presentable condition. If grown at all here it should be as in the mausoleum grove, as a demonstration and an experiment.

Periwinkle.—For St. Louis probably the most generally satisfactory ground cover other than Baltic ivy is the common periwinkle, *Vinca minor.* It is often called "Myrtle" in America, but that name rightly belongs to a very different plant which is not hardy here, a lustrous-leaved shrub with fragrant white

flowers. Its general effect and its cultural requirements are much like ivy. It is superior in that it makes a somewhat lower, more delicate cover than the ivy and its blue flowers are attractive in the springtime. On the other hand, it is slower growing than the ivy and harder to get well established. Like the ivy it will grow well on a gentle slope, and where properly cared for it may make a good soil binder for a steep bank.

Lily-turf.—Lily-turf, or *Liriope Muscari,* will be a new name to all but the most discerning. While liriopes have been in cultivation in America for many years they have been largely thought of as house plants, or as edging plants for use in conservatories. Their use as a ground cover in the north is largely due to the insistence of Mr. H. Harold Hume of Florida that they were hardier and more versatile than had been generally thought. There is more than one species in the genus, and at least one variety with variegated leaves, but the only one to be recommended for St. Louis is *L. Muscari.* It has narrow leaves rising from a central crown, and bears in late summer an inconspicuous spike of purplish blossoms. It increases slowly but steadily year after year and eventually makes a mat of wiry, grass-like leaves. It will be too tall for many situations, but the leaves are evergreen in all but the most severe winters and are effective in late fall or early spring when most of the garden is brown. The tips of the leaves burn black somewhat in hot summers and the plants do not increase as rapidly as one might wish but it is a very distinct addition to St. Louis gardens and should be much more widely known and grown.

Gill-over the-Ground.—This old-fashioned plant is really a close relative to catnip and is sometimes called ground mint, or ivy mint, its scientific name being *Nepeta hederacea.* Its worst faults are its somewhat weedy aspect and the fact that it dies out during dry spells if not abundantly watered. It is lighter green than true ivy and the leaves are somewhat softer in texture. In some of the beds at the Garden it has been grown in combination with ivy with pleasing results.

Lily-of-the-Valley.—Though scarcely a ground cover these old-time favorites can be grown in shady places and may well be included in the discussion. They increase too slowly to be gen-

erally useful and are very intolerant of hot summer sun. In growing them it should be remembered that they respond well when given regular top-dressings of well-prepared compost.

Sedum sarmentosum.—This rampant stonecrop is sometimes used as a ground cover. It is prone to get very spotty, dying out in the middle of the bed and running like a weed around the edges. Furthermore, it does not like dense shade and to many eyes has a rather coarse appearance.

Plantain-Lilies.—These old-fashioned perennials variously known as funkias, or white day-lilies, are too big and too clumsy to make a really good ground cover, though several of the smaller species and varieties are useful, particularly as an edging plant. Of those grown at the Garden, *Hosta japonica* has proved to be the most satisfactory, though its leaves burn somewhat during hot summers.

Ceratostigma plumbaginoides.—This versatile plant was described and figured in the BULLETIN for October, 1935, in connection with its use as a filler in the late summer rose garden. It seems equally at home in the shade, though when grown there it develops so differently that one might well believe it was another species altogether. Its flowers are a lighter and less intense, though if anything a livelier shade of blue, and they are scattered here and there instead of forming a sheet of solid bloom. As a ground cover it is not fully hardy, more or less dying out in the coldest winters. However, it can be carried over in a few pots in the greenhouse or in a cold-frame. Fortunately, it freezes out much less readily when grown as a ground cover than when it is grown as a perennial in the flower garden. It is readily propagated either by division or by cutting the rhizome up into sections of about two joints and sprinkling them on flats of sand, then covering very lightly with sand and tamping down firmly.

The above list by no means exhausts the possibilities for the St. Louis region, but it does include all those which have been given a thorough trial at the Missouri Botanical Garden. Others have been added to the collection, as, for instance, the recently introduced Balkan ivies; still others will be added in the future. We shall be pleased to hear from any Middle-western gardeners who may have other ground covers to suggest.

G. H. P.
E. A.

FREE-BLOOMING CACTI FOR THE AMATEUR

Very often the cactus beginner loses interest in these fantastic plants simply because a great majority of them seem temperamental as to blooming. Temperamental they are, to be sure, but this fault can be very readily traced to the culturist. Keeping the plants in the dark, allowing no rest period, and poor circulation of fresh air are some of the chief reasons why fleshy-stemmed plants from the desert will not bloom. Until the cactus grower learns about the behavior of his plants, many days of woe and perhaps total discouragement are in store for him. For seasonal care of these succulent plants the reader is referred to the September, 1935, issue of the BULLETIN. Many free-blooming cacti can be grown by the amateur, and beginners are often perplexed as to which kinds to choose. As the subject is too big for this limited space, only a few of the better-known varieties can be mentioned here:

The flabby-textured twisted-rib *(Hamatocactus setispinus)* adapts itself readily to cultivation. It is one of the most persistent of bloomers throughout the summer months, flower after flower making its appearance. The plant is globose to cylindrical in form and is very easily recognized by certain characteristics peculiar to it. A conspicuously hooked spine arises from the center of each areole, from which character the generic name Hamatocactus is evolved. Fourteen to sixteen slender spines radiate from each areole, sometimes all white, again brownish-red, but very often mixed, the upper spines of one color and the lower ones of another. The central hooked spine is usually stronger and reddish-brown with a yellowish to white tip. The fragrant flowers are satiny, yellow with red centers, about two inches long and fully as broad when expanded. The young flower buds, which always appear from small areoles near the top center, are covered with imbricated scales. The plant bears fruit in abundance. Mature seeds, when planted, should germinate within a month.

The spineless sea-urchin *(Astrophytum asterias)* is another profuse bloomer, flowering from April to October (pl. 45, fig. 1). The plant is hemispherical and divided into segments by eight low ribs, sprinkled here and there with almost microscopic tufts of

SEA-URCHIN CACTUS

LACE CACTUS

PINCUSHION CACTUS

woolly hairs. Down the middle of each rib appear the prominent areoles which are felted but without spines or bristles. The flowers are about two inches long and fully as broad, and, like those of the twisted-rib, are yellow with red centers. The ovary and flower tube are densely covered with long brown woolly hairs and a few bristles. This cactus blooms when quite young, and seedlings, when grafted upon an Echinopsis stock, will flower in their second year. As one of the rarer cacti, it was first introduced to the European horticulturists in 1843. Immediately it became a prime favorite, the cactus enthusiasts of that continent paying as much as ten to twenty dollars for one of these plants.

Among the hedgehog cacti, one of the most common as well as one of the most beautiful is the lace cactus, *Echinocereus Reichenbachii,* (pl. 45, fig. 2), a native of Texas and Mexico. It is a very variable and spiny species but fortunately the spines are soft and the plants can be handled with impunity. Twenty to thirty interlocking spines appear from each areole, some of which are all brown and some white with dark brown tips. The flowers are very fragrant and of a deep lilac-purple shade. Attaining a size of three and one-half inches, they are among the largest known for this group. Their existence is somewhat short-lived, however, as they always close at night and stay open but one or two days.

Another hedgehog cactus worthy of cultivation is *Echinocereus papillosus.* This strongly tubercled plant grows in clusters. Its flowers are fragrant, quite large, and pale lemon-colored with red centers. The yellow color of the flowers is rare in the genus and easily distinguishes this species. Seven to eight acicular spines arise from each areole and very often two to five spine-like bristles also appear at the upper part of the areole. The radial spines are white to dirty yellow in color and the central spine is much longer and darker. Many other species of Echinocereus are profuse bloomers, the greater majority of the flowers being crimson to purplish in color.

The pincushion cacti (Neomammillaria) are very odd, ball-like plants, for the most part spring bloomers. They are distinguishable by their teat-like tubercles that are terminated by a diadem of slender spines. *Neomammillaria applanata,* from

Texas, is one of the most desirable of the cushion-like forms (pl. 45, fig. 3). Its cream-colored flowers appear as a crown around the top of the plant. Frequently, scarlet club-shaped fruits from last year's blossoms will make their appearance with the new flowers and give a pleasing effect. These fruits, resembling chili peppers, are full of small black seeds which, when sowed, should germinate within twenty days.

The above cacti are but a few of the free-blooming types which the author recommends for the novice, if certain satisfaction is to be derived from this fascinating hobby.

L. C.

NOTES

Mr. L. P. Jensen, Manager of the Arboretum, has been re-elected president of the Garden Club of Gray Summit, Missouri.

The Yugoslavian Government has conferred upon Dr. Edgar Anderson, Geneticist to the Garden, the Order of the Yugoslavian Crown (4th class) in recognition of his botanical studies in the Balkans.

Dr. C. W. Dodge, Mycologist to the Garden, lectured before the Facultad de Medicina, San José, Costa Rica, September 18, on "Sobre Algunos Aspectos Clinicos de las Enfermedades Producidas por Hongos."

The members of the Greater St. Louis Association of Gardeners visited the Arboretum, August 9, and Mr. L. P. Jensen, Manager of the Arboretum, spoke to them on "The History of the St. Louis Association of Gardeners."

The St. Louis Association of Gardeners held its October meeting at the Garden, October 4; and Mr. G. H. Pring, Superintendent of the Garden, gave a talk at the meeting on "The Effect of Drought and Heat on Plants."

There are just now coming into flower in the Desert House a number of interesting plants related to the milkweeds. Particularly magnificent is *Stapelia gigantea* with star-shaped, greenish flowers nearly a foot wide, fantastically webbed with thin lines of bright purple.

Dr. Edgar Anderson, Geneticist to the Garden, is the author of a paper in the September issue of *Rhodora* (**38:** 301-304) entitled "Color Variation in Eastern North American Flowers as Exemplified by *Hepatica acutiloba*." Dr. Anderson attended the summer meetings of the Genetics Society, at Woods Hole, Mass., September 4 and 5, and presented a paper "Hybridization in Natural Populations of Tradescantia."

Mr. L. P. Jensen, Manager of the Arboretum, acted as judge of the floricultural exhibits at the Missouri State Fair, Sedalia, Mo., August 25-26; and spoke before the members of the Missouri Federation of Garden Clubs, at Sedalia, August 26, on "Conservation of Missouri Plant Life." On September 21-24 he attended the convention of the American Institute of Park Executives, at Cincinnati, Ohio.

Dr. Carroll W. Dodge, Mycologist to the Garden, assisted by Mr. Verne T. Goerger, spent the summer in Costa Rica collecting lichens and fungi. Living orchids from Rio Paguita and Golfo Dulce were shipped to the Missouri Botanical Garden Tropical Station, Balboa, Canal Zone. About half the time was spent in the lowlands along the Pacific Ocean southeast of Puntarenas, in areas rarely visited by botanists, and the rest of the time divided between the Atlantic lowlands and the Meseta central.

Among the recent visitors to the Garden were Dr. Lawrence M. Ames, of the U. S. Department of Agriculture, Division of Plant Disease Eradication and Control, Barberry Eradication, at the Arnold Arboretum, Boston, Massachusetts; Mr. Louis C. Wheeler, Assistant in the Gray Herbarium of Harvard University, Cambridge, Massachusetts; Mr. J. Horace McFarland, the well-known rosarian and editor of *Breeze Hill News,* Harrisburg, Pennsylvania; Dr. Forrest Shreve, in charge Desert Laboratory of the Carnegie Institution of Washington, Tucson, Arizona; Mr. Reginald Forwood, Mycologist, of Minett, Canada.

Mr. Paul H. Allen has been appointed Manager of the Tropical Station at Balboa, Canal Zone, to succeed the late Mr. A. A. Hunter. Mr. Allen completed his apprenticeship at the Garden in 1935 and for the past year has been preparing himself for his duties at the Station. He spent six months on the Canal Zone

in 1934-35 and had the advantage of visiting many of the collecting grounds discovered by Mr. Hunter. His experience both at the Garden and at the Tropical Station has well qualified him for the position he is assuming. Mrs. Hunter, who has been temporarily in charge of the Station, is returning to the States. She has administered the Station in an admirable manner but now desires to leave the tropics.

STATISTICAL INFORMATION FOR SEPTEMBER, 1936

GARDEN ATTENDANCE:

Total number of visitors	25,325

LIBRARY ACCESSIONS:

Total number of books and pamphlets bought	11
Total number of books and pamphlets donated	411

PLANT ACCESSIONS:

Total number of plants and seed packets received as gifts	102

HERBARIUM ACCESSIONS:

By Purchase—	
Killip, Ellsworth P.—Plants of Peru, collected by G. Klug	195
Wynd, F. Lyle—Plants of Mexico, collected by F. Lyle Wynd and C. H. Mueller	128
By Gift—	
Anderson, E.—Plants of eastern United States	23
Andrews, Henry N., Jr.—Plants of New Hampshire and South Africa	9
Ball, Carleton R.—Willows of Eastern United States	10
Boefer, Mrs. Adelaide—*Polygonum cuspidatum* Sieb. & Zucc. from Horticulture	1
Dougan, L. M.—*Polygonum cuspidatum* Sieb. & Zucc. from Horticulture	1
Dugand G., Armando by R. E. Woodson—Photograph of *Aspidosperma Dugandii* Standley	1
Erwin, A. T.—*Capsicum baccatum* L. from Horticulture	1
Greenman, J. M.—Plants of Connecticut	3
Klug, G.—Plants of Peru	39
Lodewyks, Maude C.—Plants of Tennessee	29
Seibert, Russell J.—Plants of Panama	377
von Schrenk, Hermann—Plants of Colorado	70
By Exchange—	
Morris Arboretum, University of Pennsylvania—Plants of Eastern United States	350
Total	1,237

SOME FACTS ABOUT THE GARDEN

The Missouri Botanical Garden was opened to the public by Mr. Henry Shaw about 1860. From that date to the death of Mr. Shaw, in 1889, the Garden was maintained under the personal direction of its founder, and while virtually a private garden it was, except at certain stated times, always open to the public. Although popularly known as "Shaw's Garden" the name Missouri Botanical Garden was designated by Mr. Shaw as its official title and in his will or in any of his writings he specifically referred to it as the "Missouri Botanical Garden." By a provision of Mr. Shaw's will the Garden passed at his death into the hands of a Board of Trustees. The original members of the Board were designated in the will, and the Board so constituted, exclusive of certain ex-officio members, is self-perpetuating. By a further provision of the will, the immediate direction of the Garden is vested in a Director, appointed by the Board of Trustees. The Garden receives no income from city or state, but is supported entirely from funds left by the founder.

The city Garden comprises 75 acres, where about 12,000 species of plants are growing. There is now in process of development a tract of land of over 1,600 acres outside the city limits which is to be devoted to (1) the propagation and growing of plants, trees, and shrubs, designed for showing either indoors or outside, at the city Garden, thus avoiding the existing difficulties of growing plants in the city atmosphere; (2) gradually establishing an arboretum as well as holding a certain area as a forest reservation, with the idea that possibly at some future time this may become the new botanical garden.

The Garden is open to the public every day in the year, except New Year's Day and Christmas—week days from 8:00 a. m. until sunset; Sundays from 10:00 a. m. until sunset.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Place, on the Sarah car line (No. 42). Transfer south from all intersecting lines.

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MISSOURI BOTANICAL GARDEN BULLETIN

Vol. XXIV NOVEMBER, 1936 No. 9

CONTENTS

	Page
That Elusive Neomammillaria Wrightii	201
Plant Life in the Grand Canyon Region	205
Winter Courses in Gardening for Amateurs . . .	208
Notes	211
Statistical Information	213

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NEOMAMMILLARIA WRIGHTII (two-thirds natural size)

UNUSUAL GROWTH OF NEOMAMMILLARIA WRIGHTII DUE TO ETIOLATION

Missouri Botanical Garden Bulletin

Vol. XXIV NOVEMBER, 1936 No. 9

THAT ELUSIVE NEOMAMMILLARIA WRIGHTII

Frequently chance plays an important role in the making of history. It was by chance that Columbus found America instead of a shorter route to the Orient. It was by accident that quinine was discovered by a fever-stricken Peruvian Indian, who drank of water impregnated with the curative substance from the bark of fallen cinchona trees in a near-by stream. It was chance again that played such an important role in the discovery of America's greatest subterranean marvel, the Carlsbad Caverns. The spectacle of millions of bats emerging from a dark hole in the side of a rocky hill being witnessed by a lonely cowboy riding herd in the vicinity led to the exploring of the mystery that lay beneath the cactus-covered soil of the Guadalupe foothills. Innumerable other instances can be recounted wherein chance or pure accident made history, revolutionized industry, or indirectly brought wealth and happiness to individuals upon whom Dame Chance deigned to smile. All of this may seem correspondingly uninteresting to the reader, yet it is quite essential in the relating of this story.

It was chance that led the Garden's floriculturist to vacation in northern New Mexico last August. The writer had asked him to collect any small native cactus he perchance might come across. Incidentally, Mr. Paul A. Kohl, the aforementioned gentleman, without knowing it, picked up four or five small cacti which turned out to be the almost extinct and seldom-seen *Neomammillaria Wrightii* (Engelmann) Britton & Rose. Over eighty years have elapsed since Bigelow found specimens of this pincushion cactus

growing on the hills and rocky places near Anton Chico, on the Pecos River, some sixty miles southeast of Santa Fe, the type locality for the plant. Not until almost three years later was its name published. Dr. George Engelmann, to whom was entrusted the descriptions of most of the cacti found in the U. S.-Mexican Boundary Survey, named it *Mammillaria Wrightii* in honor of Charles Wright, who did extensive exploration along the Mexican boundary line and also in other parts of the Americas. Evidently this cactus was quite scarce at the time of its discovery and became even rarer in collections as the years rolled by. Britton and Rose, who changed the generic name to Neomammillaria, had not even a photograph of this rarity to include in their monumental work "The Cactaceae" and so borrowed the illustration from the Mexican Boundary Survey. The drawing, showing the whole plant in fruit; was made by Mr. Paulus Roetter after a sketch of Mr. Moellhausen's made on the spot and is very excellent in all details. Indeed so splendid a work was done by that St. Louis artist for the Mexican Boundary Survey that a cactus was named in his honor, *Echinocereus Roetteri.*

That *Neomammillaria Wrightii* was always a rare species is attested by the fact that very little material is included in prominent herbaria of the world today, and that very few collectors have been able to locate the plant. This cactus has been entirely exterminated in its original locality by grazing animals, and if it still exists in the mountains of northeastern New Mexico, it will suffer a like fate, as the region is overrun with sheep and goats. In 1896, J. W. Toumey found this elusive cactus at White Oaks, in Lincoln County, about 120 miles southwest of Anton Chico. For four successive years (1930 to 1934) Mr. Cleve Hallenbeck, a very enthusiastic student of New Mexican cacti, has been on the lookout for this rarity in his native state. He travelled some 2600 miles by car and tramped many additional miles in the regions where "Wrightii" might be found, but all this diligent search netted him nothing until, almost on the point of defeat, he decided to make one last effort in one of the unexplored canyons near Anton Chico. To his surprise this last resort proved fruitful, a colony of fifty plants rewarding his search. Other collec-

tors in recent years have sought just as industriously for this elusive plant, but to no avail.

Mr. Kohl's plants, four in number, were found on the grassy slopes in the region, where U. S. Highway 66 crosses Arroyo Hondo, near La Loma, about six miles south of Santa Fe, during the week of August 23, 1936. They were all of blooming size, about 1½ inches in diameter and not much more in length. These diminutive cacti were extremely hard to find, as but the very tops were exposed above ground and furthermore the gramma grass which grew all around them hid them from view. Other distinctive plants growing at this high elevation (7000 ft.) and keeping company with this much-esteemed cactus were a narrow-leaved yucca (possibly *Y. glauca*), a tree cholla (the common *Opuntia imbricata*), pinon pine *(Pinus edulis?)*, and juniper (*Juniperus* sp.).

A detailed description of *Neomammillaria Wrightii* is here given, taken from notes on the plants now in the collection of the Missouri Botanical Garden. The stems are simple, somewhat hemispherical with a flattened top, while the lower part of the plant (the part underground) is top-shaped. A few thickened roots appear, extending downward and some laterally near the surface. The plant body is usually 5 cm. high and about equal in width at the top. Tubercles are somewhat loosely arranged, conspicuously long (about 15 mm.), terete, flabby-textured, of a dark green color, and somewhat glistening, as if faintly sprinkled with silver dust. Very often the tubercles are slightly bent or curved and in their axils are naked. The areoles are small, circular, with slender spines and short white wool which is gradually lost with age. Radial spines are normally 12 to 14 in number, spreading, acicular to almost bristle-like, of about equal length, with perhaps the lower ones somewhat smaller. There is some variation in the number and color of spines, but generally the lowermost are white, the laterals are brown-tipped, and the uppermost are brown either for their entire length or for just a third of the way down. All of these turn grayish in age. One to three central spines will emerge from an areole, these somewhat stouter than the radials, of a reddish-brown to black color, and very often all of them are hooked at the apex, the hooks

usually turned down and again in different directions. When two centrals appear from an areole they usually are side by side, diverging laterally, and perhaps not frequently they will appear one above the other. If three centrals appear, the third one is below the other two. It is said that sometimes four or even five centrals are not unusual in some individuals.

The flowers are bright purple, but detailed description cannot be given at this time as blossoms were not seen by the writer. The fruit is dark green in color, turning purplish in maturity, naked, juicy, and about 1.5 cm. long. As a rule the withered perianth persists for a long time, even to the ripening stage of the berry. Seeds are black, about 1 to 1.5 mm. long, and average about three hundred for each berry. The fruit is moved outward by the continuous growth of the plant, and leaves a large, deep impression when finally removed. In appearance *N. Wrightii* is similar to *N. Wilcoxii* and *N. viridiflora,* but it can be readily distinguished from both by the fewer radial spines which do not seem to hide the plant body as in the latter two species, and also by other minor differences.

A freakish *Neomammillaria Wrightii* was brought to the attention of the writer by a St. Louisan, who had spent some time vacationing in Santa Fe. Originally the specimen was a perfectly normal plant collected in the same territory as the above four plants. Transplanted into a small earthen jar, it was brought home as a souvenir and because this pincushion cactus was kept on a shelf in a darkened corner of a St. Louis home, it produced a tall, spindly terminal growth about two inches long, giving the effect of having been grafted upon a totally different species. The whole plant was light green in color, due to house culture, and the tubercles, though shining, did not have that glistening appearance of the plants growing outdoors. The slender, bristle-like spines arising from tiny areoles on the stem were covered with minute short hairs. This freakish growth may appear on other cacti in various forms, as well as on any other plant, when grown in darkened places. It is known as an etiolated growth (due to absence of sunlight), and such growths are susceptible to all sorts of diseases and insect pests and if not watched carefully may succumb very readily to attack.

L. C.

PLANT LIFE IN THE GRAND CANYON REGION

America's most turbulent river, the mighty Colorado, which springs from tiny rivulets that have their source in the snows of the Rockies, has carved for mortal man the greatest attraction on this continent. Ferociously and ceaselessly this savage water-god has cut itself a series of deep channels through solid granite and other rock, the like of which has no equal in this world. Even its many arms, the meandering tributaries of this snarling stream, have carved deep abysmal gorges which often rival in grandeur those of the main stream itself. It is now almost four hundred years since the white man first beheld this mammoth chasm, but it was not until after the Civil War that the Grand Canyon was wholly explored and publicized. Today, thousands of visitors, come each season to view this stupendous spectacle of the Colorado River, but few of them realize that the vegetation of the Canyon region is likewise very interesting. Prickly pear, barrel cacti, yucca, salt-bush, and sage-brush predominate, all these characteristically quite in keeping with the quaint desert topography.

Most of northern Arizona is composed of arid tableland with many broken hill formations and picturesque, deeply-cut canyons. In the vicinity of Ashfork, some sixty miles south of the Grand Canyon, as far as the eye could see, *Gutierrezia tenuis* spreads a radiant blanket to the very edge of the highway. This bushy plant, a member of the composite family, bears innumerable heads of tiny yellow blossoms which are particularly striking against a background of the bluish-green junipers that stretch for miles and miles in the Tusayan National Forest. North of Williams, which is 6752 feet above sea-level, fields of the common salt-bush, *Atriplex canescens,* are very prominent. This is one of the commonest shrubs over the plains of western United States and very frequently is mistaken for the sage-brush by the newcomer, because of its grayish appearance. It is an evergreen bush, belonging to the same family as the medicinal weed that is known as "wormseed," and on the plains of western United States it is a very valuable emergency feed for range cattle. Like the creosote bush *(Covillea tridentata),* it is deeply rooted and new top growth will not appear until a lengthy root system is developed

in order to garner the moisture from the lower levels of the dry upper surface of the plain. Still farther north the salt-bush seems to vanish and in its stead the real sage-brush (*Artemisia tridentata*) makes its appearance, fields and fields of it growing to the very limits of the Grand Canyon itself. The sage-brush may reach a height of ten feet, but in this region it is very seldom over four feet. This much-branched shrub has a trunk with characteristically shredded bark, and the twigs and leaves are covered with a silvery down reminiscent of *Artemisia* "Silver King" which is greatly used in our gardens today.

Entering the Grand Canyon National Park by auto through the little village of Tusayan, near the South Rim, the visitor traverses a forest of pine. Six miles hence he arrives at the checking station, where he is requested to register and where maps of the trails can be secured free. At Hopi House, which is a reproduction of the type of dwelling in which the Hopi Indians live, the writer secured his first glimpse of the mighty canyon. The view from this point is somewhat restricted, because points of the plateau reach far out into the canyon on both sides. Standing on the brink of this deep abyss, the onlooker stares down and then across this gigantic hole in the ground and remains speechless for a long time. Mere words cannot describe the grandeur of the Canyon. It leaves a powerful impression of something that is unreal, silent, and mystifying. But as the eyes get accustomed to this seemingly unreal spectacle, one perceives strange architectural forms, massive pyramids, and ornate temples, arising slowly from the depths, some of which are so tall that they reach the level of the canyon rim itself. Changing lights and shadows play fantastically upon the eroded walls, temple walls glow with color, some forms seem to disappear while others make their appearances. And even on dull days, as the writer had noted, a constantly changing kaleidoscope of color transformed the Canyon into a motion picture of beautiful somber tones.

A footpath along the rim leads to many points where interesting views of the canyon can be had. The observant nature-lover will note the rich semi-arid vegetation that is to be found along this trail. The forest is made up of pines, and everywhere the gnarled and somewhat stunted "Cliff Rose" lends enchantment

to the scene. This member of the rose family, *Cowania Stansburiana,* with its picturesquely gnarled and twisted branches, is the most impressive shrub of the Grand Canyon region, at least in the writer's opinion. Along the south rim it attains an average height of about six feet and grows to the very edge of the Canyon, oftentimes overhanging the rocky rim of this deep abyss. The gray bark hangs in untidy shreds from the crooked branches, giving the plant the appearance of a tree from Dante's "Inferno." The small, many-lobed, leathery, evergreen leaves glisten in the sun and offer a fine setting for the light yellow blossoms. Because the styles are beautifully plumose and stay for a long time after the petals have dropped, the attractiveness of the plant is doubly increased. Seeds were collected and an attempt will be made to grow the "Cliff Rose" at the Garden.

Another very pretty and unusual-looking bush that clings to the edge and overhangs the depths is *Chamaebatiaria Millefolium,* to which the common name of "Fern-bush" is applied. It is another member of the rose family and, like the "Cliff Rose," has a shreddy bark. The yellowish-green leaves are covered with down and are arranged in bunches at intervals along the reddish stems. Flowers appear as late as September.

Among the rocks in the Grand Canyon, as well as along the rim, a peculiar, fleshy-fruited member of the lily clan, *Yucca baccata,* can be found growing. The plant consists of a low rosette of stiff, bluish-green leaves with coarse threads along their margins. The fleshy fruit, attaining a length of about eight inches, can be eaten and is eaten raw by the Navajo Indians of this region. The root of this particular yucca is of a saponaceous character and, because of it, is macerated and rubbed in water to produce suds for bathing purposes. As a shampoo it is excellent, and when a Hopi maiden is about to be married, it is a custom of the prospective mother-in-law to wash the girl's long jet-black hair in suds from the root of this plant.

A cactus companion growing with *Yucca baccata* is *Opuntia Engelmannii,* the common white-spined prickly pear. A small, compact, glaucous-leaved century plant, *Agave utahensis,* is prominently featured on the rocky slopes in the Grand Canyon. An interesting rosaceous plant which covers the Canyon plateau is

Coleogyne ramosissima or "Burro-brush." Its very small, narrow, leather-like, downy evergreen leaves are clustered in small bunches along the stiff, almost forbidding branches.

A well-paved auto road stretches for miles along the South Rim eastward from the El Tovar Hotel. At times it follows the very rim of the canyon, then again it winds through the pine forest, to emerge at some vantage point where a breath-taking view of scenic grandeur is unfolded. Driving along this green-bordered highway, the early-morning visitor may catch glimpses of deer that roam at peace in this forest, but they will flash by too quickly for a snapshot. At Navajo Point (elevation 7450 ft.) the writer secured his last view of the mighty gorge, after which his course deviated southeastward toward the Little Colorado River. This offspring of a mighty stream, too, has carved a gorge for itself, patterned in a miniature Grand Canyon style. In this vicinity *Opuntia Whipplei,* a low, much-branched, and widely spreading, cholla-type cactus was much in evidence. This plant has fibrous roots and prominent areoles from which spring silvery spines that glisten in the sun. A specimen collected just south of the Little Colorado Canyon is now thriving in the Garden's collection of succulent plants.

The Grand Canyon region is very rich in flowering vegetation, but the writer enumerates only those species that will most likely attract the attention of visitors to this famous playground of the Southwest.

L. C.

WINTER COURSES IN GARDENING FOR AMATEURS

ELEMENTARY COURSE

The elementary course in various phases of gardening for amateurs, which has been conducted at the Garden for the past few years, will be repeated in 1937. As formerly, it will commence in January, since it is believed that the course is of more value when given earlier in the year. The class will meet in the lecture room of the museum building (entrance at Tower Grove and Cleveland Avenue gate) at 3:45 p. m., Monday afternoons of each week.

REGISTRATION: It is desirable that registration be made by letter, with check payable to the Missouri Botanical Garden enclosed, as soon after December 20 as possible. Tickets will be ready for distribution on day of first lecture. Registration fees will also be received on January 4 at the lecture hall, at 3:00 o'clock.

FEES: The registration fee is $5.00 for each person, and tickets are not transferable.

The outline of the subjects to be discussed follows:

January 4—Brief discussion of catalogues, horticultural magazines, and bulletins. Illustrated lecture and instruction on rock gardens and wall gardens. The use of hot-beds and cold-frames..Kohl

January 11—Trees and shrubs:
Pruning of shrubs at planting time.
Summer and winter pruning of trees and shrubs with relation to the time of bloom, i. e., trees and shrubs flowering in spring from buds formed the previous season; those blooming in summer on wood made during the current season.....Beilmann

January 18—Annuals, perennials. Illustrated lecture.....Kohl

January 25—The general care of trees:
Tree surgery.
Fertilizers.
Pruning.
Spraying.
Cabling.
Transplanting .....Beilmann

February 1—Roses. Illustrated lecture.....Kohl

February 8—Lawns:
Seed lawns: Preparation of the soil, seed selection, fertilizers.
Stolon lawns: Methods of planting by means of stolons and plugging.
Lawns and their subsequent care.....Pring

February 15—Raising plants from seed. The students will sow seeds of annuals and perennials in the greenhouses, later transferring the plants to their own gardens. Students will furnish their own seeds .....Fairburn

February 22—Iris, peonies, and bulbs. Illustrated lecture.....Kohl

March 1—Controlling insect pests. Material to use.....Beilmann

March 8—Water gardens. Illustrated lecture.
Construction of pools.
Preparation of soil and planting.
Caring for hardy and tropical water-lilies during growing season.
Propagation by seeds, tubers, leaves.
Breeding.
Winter storage .....Pring

March 15—The home culture of cacti and other succulent plants.
Illustrated lecture:
Kinds for the beginner to grow.
Soil, air, light, temperature, and moisture.
Propagation by seed, cuttings, and grafting.....Cutak

March 22—Practical demonstration in the greenhouse of potting seedlings .....Fairburn

ADVANCED COURSE

The advanced course in gardening for amateurs will start February 4. The purpose of this course is to give the students as much practical work as possible. They will have an opportunity to propagate various types of plants, handle soil, experiment with different fertilizers, force bulbs, etc., in the greenhouse. The classes will be held in the experimental greenhouses from 10 to 12 a. m., Thursday of each week.

REGISTRATION: Enrollment limited to 30 students. The elementary course or previous gardening experience is a prerequisite to this advanced course.

FEE: The registration fee is $10.00 per student and tickets are not transferable. Write or phone the Garden, Pr. 5567, for reservations.

February 4—The selection and care of house plants:
Exhibit of desirable house plants. How to grow them successfully. Forcing of bulbs.

February 11—Soil management:
The characteristics of "good" soil. Study of drainage and demonstration of soil testing. Preparation of fertile garden soil.

February 18—Fertilizers:
How to improve soils by the use of fertilizers. The students will start an experiment in the greenhouse to show the effects of various fertilizer treatments on plant growth.

February 25—Insects and diseases:
Identification, control and injury caused by common garden pests. Exhibit of harmful insects, diseases, injury to plants, insecticides, fungicides, sprayers, dusters, etc. Books and bulletins on plant pests.

March 4–April 1—Plant propagation:
The propagation of plants is one of the most important and interesting phases of gardening. Five class periods will be devoted to this subject in order that the students may become familiar with a wide variety of plants and their methods of increase.

a. Seed.
b. Stem cuttings.
c. Leaf cuttings.
d. Root cuttings.
e. Hardwood cuttings.
f. Rootstocks or rhizomes.
g. Tubers.
h. Tuberous roots.
i. Bulbs, bulb scales, corms, cormels.
j. Viviparous leaves.
k. Stolons.
l. Layering.
m. Grafting, budding.

April 8—Potting of plants raised from seed.

April 15—Potting of plants raised from cuttings.

April 22—Landscaping the home grounds:
The selection, arrangement, and care of trees, shrubs, and flowers. Lawns.

April 29—Trip to the Garden Arboretum at Gray Summit where the students will have an opportunity to see the large collection of orchids, the pinetum, the nursery, and much of the native flora.

NOTES

Mr. Paul A. Kohl, Floriculturist to the Garden, spoke before the Garden Club of St. Louis, October 28, on "Hardy Chrysanthemums."

Dr. Jesse M. Greenman, Curator of the Herbarium, spoke at the meeting of the Academy of Science of St. Louis, October 28, on "The Herbarium of the Missouri Botanical Garden."

Dr. Carroll W. Dodge, Mycologist to the Garden, gave an illustrated lecture on "Costa Rica," October 20, before Phi Sigma; and November 3, before the travel group at Pilgrim Congregational Church.

Recent visitors to the Garden include Mrs. Wilhelm Munthe, of Oslo, Norway; Dr. F. J. Scully, of Hot Springs, Arkansas; Mr. A. W. Alberts, Associate Agronomist, Soil Conservation Service, Edwardsville, Illinois.

Dr. Edgar Anderson, Geneticist to the Garden, spoke before the science teachers section of the Academy of Science of St. Louis, at Soldan High School, October 22, on "How we would like you to prepare the student for botany in the University."

Dr. David C. Fairburn, Research Assistant to the Garden, has written a book "Plant Propagation for the Garden" published by

Doubleday, Doran & Co. He also has an article in the November issue of *The Modern Hospital Magazine* on "Hospital Bouquets."

Mr. Ladislaus Cutak, in Charge of Succulents at the Garden, is the author of an article in the October issue of *Cactus and Succulent Journal* (8:54-56) entitled "The Missouri Botanical Garden." An excellent photograph of the Garden's succulent house, which contains South African plants, accompanies the article and is the first published interior view of the house.

The Greater St. Louis Association of Gardeners held its October meeting at the Garden, October 4, and Mr. G. H. Pring, Superintendent of the Garden, gave a talk at the meeting on "The Effect of Heat and Drought on Plants." Mr. Pring also spoke at the twentieth-anniversary dinner of the Association of Gardeners, November 14, on "The Value of the Gardener to the Community."

Dr. George T. Moore, Director of the Garden, gave an illustrated talk before the Men's Club of the Oak Hill Presbyterian Church, October 29, on "The Missouri Botanical Garden." On November 4 he spoke before the science section of the Wednesday Club, on "Henry Shaw, the Greatest Plant Philanthropist"; and on November 13, at the luncheon of Vassar College Alumnae, at the Park Plaza, on "Some Activities of the Garden," the talk being followed by a trip through the Garden.

STATISTICAL INFORMATION FOR OCTOBER, 1936

GARDEN ATTENDANCE:

Total number of visitors	36,689

LIBRARY ACCESSIONS:

Total number of books and pamphlets bought	13
Total number of books and pamphlets donated	307

PLANT ACCESSIONS:

Total number of plants and seed packets received as gifts	61

HERBARIUM ACCESSIONS:

By Purchase—	
Wynd, F. Lyle—Plants of Mexico, collected by F. Lyle Wynd and C. H. Mueller	511
By Gift—	
Bailey, L. H.—*Trachelospermum jasminoides* (Lindl.) Lem.	1
Barkley, Fred A.—Marine algae from New York	4
Dodge, C. W.—Plants of Costa Rica	32
Goodspeed, T. H.—Seeds of South American Senecios	6
Kellogg, John H.—*Veronica connata* Raf. var. *glaberrima* Pennell from Missouri	2
Little, Elbert L., Jr., by F. A. Barkley—*Moenkemeyera Littlei* Williams from New Mexico	1
Lundell, C. L., by R. E. Woodson, Jr.—Plants of Central America	2
Ownbey, Marion—Senecios of Wyoming	11
Rehder, A., by E. Anderson—*Caryopteris incana* Miq. from Horticulture	1
Sayres, F. W.—*Cotinus americanus* Nutt. from Missouri	1
Seibert, R. J.—Plants of Panama	27
Williams, Louis O.—Senecio and Castilleja from Wyoming and Colorado	43
Woodson, R. E., Jr.—Plants of Guatemala collected by W. A. Schipp	4
By Exchange—	
Duke University—Plants of North Carolina	200
Gray Herbarium of Harvard University—Plants of Brazil	122
Gray Herbarium of Harvard University—Plants of Cuba	115
By Transfer—	
Anderson, E.—Plants of Horticulture	4
Cutak, Ladislaus—Plants of Horticulture	1
Total	1,088

SOME FACTS ABOUT THE GARDEN

The Missouri Botanical Garden was opened to the public by Mr. Henry Shaw about 1860. From that date to the death of Mr. Shaw, in 1889, the Garden was maintained under the personal direction of its founder, and while virtually a private garden it was, except at certain stated times, always open to the public. Although popularly known as "Shaw's Garden" the name Missouri Botanical Garden was designated by Mr. Shaw as its official title and in his will or in any of his writings he specifically referred to it as the "Missouri Botanical Garden." By a provision of Mr. Shaw's will the Garden passed at his death into the hands of a Board of Trustees. The original members of the Board were designated in the will, and the Board so constituted, exclusive of certain ex-officio members, is self-perpetuating. By a further provision of the will, the immediate direction of the Garden is vested in a Director, appointed by the Board of Trustees. The Garden receives no income from city or state, but is supported entirely from funds left by the founder.

The city Garden comprises 75 acres, where about 12,000 species of plants are growing. There is now in process of development a tract of land of over 1,600 acres outside the city limits which is to be devoted to (1) the propagation and growing of plants, trees, and shrubs, designed for showing either indoors or outside, at the city Garden, thus avoiding the existing difficulties of growing plants in the city atmosphere; (2) gradually establishing an arboretum as well as holding a certain area as a forest reservation, with the idea that possibly at some future time this may become the new botanical garden.

The Garden is open to the public every day in the year, except New Year's Day and Christmas—week days from 8:00 a. m. until sunset; Sundays from 10:00 a. m. until sunset.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Place, on the Sarah car line (No. 42). Transfer south from all intersecting lines.

STAFF
OF THE MISSOURI BOTANICAL GARDEN

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MISSOURI BOTANICAL GARDEN BULLETIN

Vol. XXIV DECEMBER, 1936 No. 10

CONTENTS

	Page
Notice of Importance to Bulletin Readers	215
A Most Useful Plant Family, the Anacardiaceae	216
Another Drought Warning	229
Notes	231
Statistical Information	233
Index to Illustrations of Volume XXIV	235
General Index to Volume XXIV	237

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Missouri Botanical Garden Bulletin

Vol. XXIV DECEMBER, 1936 No. 10

NOTICE OF IMPORTANCE TO BULLETIN READERS

The first number of the MISSOURI BOTANICAL GARDEN BULLETIN appeared in January, 1913. At that time it was intended as a means of "informing the people of St. Louis and vicinity what can be seen and learned at the Missouri Botanical Garden." During the subsequent twenty-four years the scope of the BULLETIN has expanded far beyond the original plan. Scarcely a number appears but one or more articles are widely copied in leading horticultural and floricultural journals, so that the BULLETIN has come to be recognized as containing information of value to the country at large. Several numbers have had to be reprinted because of the widespread demand, and permission to republish certain articles has been given to commercial concerns for distribution by the thousands to their customers.

Because of the greatly diminished income from the Henry Shaw Estate, the greater cost of printing, and the necessity for a larger edition of the BULLETIN, there has been a question whether it should be continued. Before coming to any decision, it has seemed worth while to attempt to increase the number of paid subscriptions in the hope that the additional revenue would justify the expense of publication.

Consequently, except where the BULLETIN is sent in exchange for similar journals, or for services rendered the Garden, its free distribution will be discontinued with this number. Those who wish to receive the BULLETIN for 1937 may remit one dollar direct, or fill out the enclosed postal card as indicated. The price of single copies will be increased to fifteen cents. If no reply is received your name will be removed from the mailing list.

If you have found the BULLETIN of value in the past, we shall be glad to receive your subscription which will help to continue its publication.

A MOST USEFUL PLANT FAMILY, THE ANACARDIACEAE

Among plant families, as among human families, there are a certain few which are outstanding. Some of these brilliant families run all to one particular talent, others are interesting because the family genius expresses itself in such diverse ways. Among the most versatile of the families of tbe flowering plants is the Anacardiaceae, to which belong the luscious mango, the nutritious cashew nut, the oriental lacquers, and the brilliantly pernicious poison ivy. Seldom in any botanical family are the useful and poisonous properties so intermingled as they are here. Besides fruits and nuts, the family yields resinous juices used for medicinal substances and varnishes, supplies valuable tanning and dyeing materials, gums, woods, and ornamental plants. With such diversity one may well ask if any features are common to the family as a whole. Such tendencies which run through the lot are almost as difficult to phrase in a few words as are the tendencies which characterize human families. If one wishes to describe a typical Adams, he mentions by name John Adams or Henry Adams or Samuel Adams and explains in what way he typifies the family and in what ways he is exceptional among them. So with the Anacardiaceae, one might well begin by saying that our sumacs and poison ivies are typical members of that family. Like them, most plants of the family are shrubby, though a few become small trees. They grow for the most part in warm temperate regions. In the New World they are common in the southern United States and Mexico, but are rarely found as far north as southern Canada. They often have tough, leathery leaves and bear an abundance of small, inconspicuous flowers which usually appear in clusters. The fruits are commonly conspicuous, often being either red or orange. Another interesting tendency is the presence of irritant-poisons among many of the genera.

Some of the Anacardiaceae have been in common use for centuries. It is probable that *Rhus coriaria* L. had a long association in the culture pattern of the eastern Mediterranean region preceding the Golden Age of Greece, for before 300 B. C. we find allusions to its use in tanning and in medicine made by Theophrastus in his *Enquiry into Plants.*

Pliny, in his *Natural History,* mentions the terebinth or turpentine tree, Cotinus, and the currier's shrub. His discussion of *Rhus coriaria* L. is particularly of interest in that it shows many of the uses that had been found for one of this family by the beginning of the Christian Era—usages which were continued for many centuries thereafter. A portion of the discussion (from Philomon Holland's English translation) follows:

> Rhus . . . called it is, the Curriers shrub, for that they vse to dresse their skins with the dry leaues thereof, instead of pomgranat rinds . . . Moreouer, Physicians imploy the medicins whereinto this Rhus is put, for bruises: likewise, for the flux proceeding from a feeble stomack, as also for the vlcers in the seat. But the leaues stamped and incorporat with hony, and so brought into a liniment or salue with vineger, do heale cankerous sores such as with inflammation do eat away the flesh to the very bone. Their decoction is singular to be instilled into the ears that run with filthie matter. Moreouer, there is made a stomaticall composition of the branches of this Rhus, boiled, which serueth in the same cases as the abouenamed Diamoron, *i.* of the Mulberries: but if it haue allum ioined withall, it is of greater efficacy. The same being brought into a liniment, is passing good for the swellings in a dropsie . . . the seed thereof is both astringent and refrigeratiue. Much vsed is the grain or seed of this Rhus in stead of salt to pouder & season meats. Laxatiue it is, and giueth a pleasant tast to any flesh meats, especially if silphium be mingled withal: tempered with hony, it cureth and healeth all running vlcers: and in that manner prepared, it is excellent for the roughness of a furred tongue, for places bruised, looking black & blew, or otherwise raw where the skin is rased and pilled off. Nothing so soon healeth any wounds in the head, and bringeth them so quickly to cicatrice. And taken inwardly with other meats, it stoppeth the immoderat flux of womens fleurs.
>
> This kitchin Rhus or meat-Sumach, is all one with the other: but that the cooks vsed the seed, and the curriers occupied the leaues and the branches.

FRUIT AND NUTS

The most important product of the family is its fruit. While few of them ever reach our northern markets, they are extremely important in the tropics where there are approximately sixty-four

edible species, twelve of which are under cultivation. The mango is without doubt the leading fruit of the Anacardiaceae. It furnishes fruit to about one-fifth of the earth's inhabitants, not only in its original home (southern Asia) but also in tropical America, Polynesia and the coastal regions of tropical Africa (5).[1] It was introduced into Brazil in the middle of the nineteenth century by the Portuguese. In India the tree has probably been cultivated for over four thousand years. It is so prominent in Hindu mythology and religious observances that there can be little doubt as to its antiquity. Hwen T'sang, a Chinese traveler, visiting Hindustan between 632 and 645 A. D., was the first person to bring the mango to the attention of the outside world. The Turkoman poet, Amir Khusrau, during the reign of Muhammad Tughlak Shah (1325-1351), wrote something to this effect (9):

> The mango is the pride of the garden,
> The choicest fruit of Hindustan.
> Other fruits we are content to eat when ripe,
> But the mango is good in all stages of growth.

The tree is evergreen, with small pinkish flowers borne in large panicles at the ends of the branchlets, more than four thousand flowers having been counted on a single panicle. The skin of the fruit is smooth, thicker than that of the peach, commonly yellow but varying greatly in color, and the flesh is orange or yellow. Some of the varieties of *Mangifera indica* L. are colored a deep yellow or apricot with a crimson blush on the cheek; others are an unattractive green. The smallest fruits are not larger than a good-sized plum and the largest weigh between four and five pounds. The spicy aroma of the better ones indicates their flavor, which has been described as a combination of apricot and pineapple, whereas the less palatable ones have a strong turpentiney taste. In the United States the cultivation of the mango (*Mangifera indica* L.) is limited to southern Florida and southern California. It has only recently been introduced into the American market but is becoming increasingly popular.

The "Pahutan" (*Mangifera altissima* Blanco) of the Philippines has a fruit resembling that of *M. indica*. The "Binjai" (*M.*

[1] Numbers in parentheses refer to references in Bibliography.

caesia Jack.) of Malacca, Sumatra, and Java has fruit of poor quality, but it is cultivated. The "Bachang" or "Ambatjang" (*M. foetida* Lour.), distributed throughout the Malaya Archipelago, has fruit the size of a plum and closely resembles *M. indica* L. "Kuwini" or "Bumbum" (*M. odorata* Griff.) is wild in Malacca and is cultivated in Java. *Mangifera sylvatica* Roxb., found in tropical Nipal, Sikkim, and Himalaya and Khasia Mountains of India, is another species very much like *M. indica*. "Bauno" (*M. verticillata* Rob.), which grows wild in the southern Philippines, has rich subacid juicy fruits of an excellent aromatic flavor. In Africa, "Ogivi" (*M. africana* Oliv.) is sold in the markets.

In addition to its use as a dessert fruit when ripe, the unripe fruit in India is put into curries, sauces, conserves, tarts, chutney, or pickles. It is also used for jellies and preserves. Recently a firm in India exported about 18,000 cans of preserved mangos to England in a single year (9).

The next most important fruit in this family is that obtained from several species of Spondias. *Spondias cytherea* Sonn., probably the most widely cultivated species, has orange-yellow fruit, about the size of a plum, and a skin like that of the mango but tougher. The juicy flesh is firm and the subacid flavor suggests the apple, thus accounting probably for its common name "Otaheite Apple." This species is supposedly indigenous to Polynesia. It was introduced into Jamaica, but has not been very popular there. In the markets of Rio de Janeiro it is sold under the name of "Caja Manga." The "Red Mombin" (*Spondias purpurea* L.) is extensively used in the American tropics which is its native habitat. In Mexico it is known as the "Ciruela" or the "Mexican Plum," and in its season it is the most common fruit in the markets. It is usually eaten fresh, though it may be boiled or dried, or made into a drink called "Cajazada" which is similar to lemonade. The "Red Mombin" has been successfully cultivated in southern Florida.

The "Amra" of the Hindus, *Spondias pinnata* (L. f.) Kurz, is another species producing edible fruit. Generally it is boiled with other ingredients, preserved, or eaten in curries. "Imbu" (*Spondias tuberosa* Arruda) is flavored somewhat like a sweet orange. In general appearance it resembles a green-gage plum.

In its native home, Brazil, it is eaten raw and also is used in making a popular jelly and a refreshing drink. Popenoe regards the "Imbu," which is relatively little known, as the best of the fruits in this genus. It was introduced into the United States in 1914.

The fruits of many other members of the family are eaten locally: *Comocladia integrifolia* Jacq., in tropical America, *Haematostaphis Barteri* Hook. f. (blood plum), *Lannea acida* A. Rich., *Pseuodspondias microcarpa* Engl. (Bao Musondo), *Sorindeia madagascariensis* DC., *Trichoscypha Redingi* DeWild., *T. Reygaerti* DeWild., and *Rhus lancea* L. f., in Africa, and *Bouea burmanica* Griff. and *Semecarpus Anacardium* L. f. in Asia. In the East Indies the fruits of *Dracontomelum mangiferum* Bl. are used like citrons, and in China the fruits of *Dracontomelum dao* Merrill & Rolfe (Yan Min) are made into a sour-sweet preserve.

The cashew nut (*Anacardium occidentale* L.) leads the nut-producing members of the Anacardiaceae. It is indigenous to tropical America, particularly Brazil. According to Popenoe the Brazilians are the only people who fully appreciate the cashew: "It furnishes food and household remedies to the poor, a refreshing beverage to the sick, a sweetmeat for tables richly served, and resin and good timber for industrial use" (9). The cashew is a spreading evergreen tree. The fruit is peculiar in that the part which would be taken for the fruit at first glance is in reality the swollen peduncle and disk, while the fruit proper is the kidney-shaped nut attached by its lower end to the peduncle. The fleshy portion is termed the "cashew apple" and this varies in size from three and one-half inches to less than two inches in length. The skin, commonly a brilliant yellow or flame scarlet, is thin and easily broken, revealing the light yellow juicy flesh.

According to Wissler (13), the cashew was cultivated in tropical America before the "discovery" of the New World in 1492. It was carried to Asia by the Portuguese about the fifteenth century. Like so many other of our economic plants, cacao, rubber, etc., it is not grown on a great commercial scale in its native home. India is today the largest producer of these nuts and the United States is her largest customer.

The cashew nut is also cultivated in East and West Africa and Madagascar. Its culture in the United States is limited to

Florida south of Palm Beach and Punta Gorda. In the state of Ceara in Brazil a national dish is made by cooking the juicy flower stems with fish. The fleshy receptacles of the red and yellow varieties are used in making a garnish for roasts and also a sauce by mixing together the juice and tapioca meal. A refreshing drink called "cajuada" is made from the apple, and also a sherbet. In Rio de Janeiro the apple may be eaten raw. The nut is almost wholly used in confectionery.

While cashews were consumed in various European countries for many years they were not in great demand, and their consumption was almost confined to India until the twentieth century. This was largely due to the fact that it seemed impossible to protect the nuts against spoilage in shipping. While it was possible to buy nuts of fairly good quality from the better bazaars, provided one obtained them soon after they had been shelled, when it came to exportation the period of exposure was so long that only a small part of the shipment ever arrived in a marketable condition. Today all of the nuts come to this country without spoilage by being sealed in cans with air replaced by a suitable inert gas.

The dark brown volatile oil between the two layers of the shell sometimes causes serious skin irritations similar to Rhus poisoning. For the nuts to be edible they must be roasted to remove the oil, which comes off as caustic fumes. Roasting also removes the shell and prevents the breaking of the kernels when the skins are peeled off.

Ranking second in importance as a nut in this family is the pistachio (*Pistacia vera* L.). The tree is a Syrian species grown in the Mediterranean region since the beginning of the Christian Era, or possibly earlier. According to Pliny, it was brought to Rome by Vitellius. The fruit is a nut-like drupe, which becomes reddish and wrinkled when ripe. The trees are planted twenty-five feet apart with one staminate to six or seven pistillate. Artificial pollination is sometimes necessary, as both sexes do not flower at the same time.

The best nuts on the market are from Sicily where trees of *Pistacia Terebinthus* L. are thinned out and grafted with scions of *Pistacia vera* L. The largest producers of pistachio nuts are in the order named: Syria, Italy, India, and Persia. The nuts are

sold either shelled or unshelled and salted. The brine in which they are soaked forms a film on the surface of the shell and on the kernel. Their chief use is in confectionery and pastries, and to some extent in ice cream. In Syria they are served at all wedding feasts, and the parting guest after a social call is always provided with a bag of the nuts. It is reported that large quantities of pistachios are shipped from Afghanistan where they are used as food, being fried in butter (11).

TANNINS AND DYES

The most outstanding of the tanning materials of the world is quebracho. While its tanning properties had been known for a long time by the South American natives, it appears to have been discovered by the commercial world only in the middle of the last century, after making its bow to the public of Europe at the Paris Exposition in 1867. Its value was soon recognized and in a few years its use had spread to the tanneries of France, Switzerland, and Germany. By the late eighties and early nineties its importation into Europe began to assume large proportions. The actual tonnage of extract consumed in the United States is far behind chestnut, but its greater concentration about counterbalances the smaller weight.

Red quebracho (*Schinopsis Lorentzii* Engl.), one of the five species of the South American genus of trees, is the most extensively used for tannin. It grows chiefly in the forests of Argentina and Paraguay in an area of approximately 300,000 square miles. *Schinopsis Balansae* Engl., found in Paraguay, is also used to some extent.

Second to quebracho in the production of tannins in the Anacardiaceae are plants of the genus Rhus. Sumac has long been used as a tanning material. The Sicilian sumac, *Rhus coriaria,* is the most valuable species. The shrub, a native of the Mediterranean region, grows on rocky slopes. The female plants produce 24 per cent tannin and the male plants 28 per cent or more. *Rhus coriaria* also yields the Spanish, Portuguese, and Greek sumac. The output of Sicily is estimated at 15,000 tons, a decrease of 50 per cent since the World War. Exportations from Palermo are to Great Britain, United States, France, and Ger-

many. The sumac is cut in July, August, and September, and spread out on the fields to dry. The leaves are then broken from the stems, packed into bags and taken to the mills where they are cleaned, ground, and sifted into three grades.

The Triest and Venetian sumac, also that from Hungary and Tyrol, is derived from *Cotinus Coggygria* Scop., the common smoke-bush. Frequently genuine sumac is adulterated with *Tamarix africana* Poir., *Pistacia Lentiscus* L., and *Ailanthus glandulosa* Desf. The leaves of *Pistacia Lentiscus* L., known as "shinia" leaves, are the most important sumac adulterant, about 100,000 tons being exported from Tunis and Sicily annually for the purpose (8).

Rhus glabra L., *R. typhina* L., and *R. copallina* L. yield the American sumac, which is inferior to the European product, imparting a dark color to light leathers. Sumac is not produced on a large scale in the United States, probably because of the cheap and easily available supply of quebracho from South America. Importations of (liquid) sumac into the United States in 1927 were 5,524,944 pounds, valued at $276,553.

The other species of sumac have local importance only. In Algeria, *Rhus pentaphylla* Desf. is used by the Arabs for tanning goat skins. *Rhodosphaera rhodanthema* Engl., of New South Wales, is used in Australia. In India, species of Lannea, and in British Guiana the bark of *Spondias lutea* L. supply tanning material.

Galls are also used to some extent for the preparation of tannin extracts. Both the Chinese and Japanese nut-galls (of *Rhus javanica* L.) furnish fine tanning material. The small tree from which these nut-galls are obtained is abundant in the Yangtze Valley. In 1900, 24,800 piculs valued at 454,584 Tls. were exported from Hankow, and in 1910, 53,784 piculs valued at 936,-234 Tls. A less common species is *Rhus Potaninii* Maxim. These galls are used for tanning only very light-colored fancy leathers as pure tannic acid is too expensive for ordinary purposes. Approximately 600,000 pounds of Chinese nut-galls are imported annually into the United States, and probably not more than a third is used in the manufacture of tannic acid.

The galls of *Pistacia Terebinthus* L. are also used for tanning.

Those of *Pistacia vera* L. yield 45 per cent tannin and are used for dyeing and tanning. These galls, with the pericarp of the fruit and the unfertilized ovaries, are used locally in India for dyeing silk and also some are exported to Persia and Turkestan (10).

Young fustic, obtained from *Cotinus Coggygria* Scop., is the source of a yellow dye for leather and for the preparation of mixed colors, especially warm bronze and tan for wool. This shrub, commonly known as the smoke-bush, grows wild from northwestern Europe to the Himalayan Mountains and western China. Although now distributed throughout the United States, it was introduced from Europe. Fustic comes into the market in sticks of various sizes up to twelve centimeters in diameter. On treatment with a potash solution the wood becomes carmine to blood-red, changing to a red-lead color on drying. The coloring principle of young fustic is fisetin which occurs combined with tannic acid as a glucoside. This yellow dye is also used in calico printing. *Cotinus americanus* Nutt. furnishes a yellow dye similar to that of *C. Coggygria* Scop.

Leaves of *Pistacia Lentiscus* L. are used in Lyons as a dyeing material for silk stuffs. The galls of *Rhus javanica* L. are mentioned as being usable for the same purposes, and in China for dyeing blue silk and blue cotton cloth black. In India a golden or pale brown tint for silk dyeing is obtained from *Lannea grandis* (Dennst.) Engl. The juices of several genera are locally used for ink.

From the Chinese and Japanese nut-galls (of *Rhus javanica* L.) are obtained pyrogallic acid, gallic acid, and tannic acid. About 600,000 pounds of these galls are imported into the United States annually for the manufacture of these acids, which have important uses in many different fields.

Gallic acid is used in tanning, and as the starting point for a blue and a brown dye. It is also extensively used in the manufacture of writing ink, the most permanent inks being made from tannic acids and gallic acids and iron salts.

Pyrogallic acid, which is obtained from gallic acid, is used as a photographic developer and is popular with many photographers because it brings out details. It is also used as a dye for furs and for wood, and a related use is in certain hair dyes. Another use

is in the preparation of dyes, such as alizarine yellow C and anthracine yellow. In the laboratory pyrogallic acid is used in preparations of solutions to absorb oxygen, particularly in gas analysis, and in the preparation of colloidal metals.

Tannic acid is used industrially in the precipitation of basic dyes. Certain coloring substances or pigments, such as lakes, are prepared by precipitating the dye onto a suitable base. These in turn are used in the manufacture of printing inks, lime paints, cold-water paints, and sometimes varnishes. As all such pigments tend to fade more or less in the sunlight their use in the paint, varnish, and lacquer field has greatly decreased in the past few years, particulalrly since light-proof lakes have been made with other chemical-precipitating agents. The printing industry still uses certain of these lakes or pigments in toners, and similar uses are found in the textile and paper industries. Basic dyes may be precitated on paper or cloth. Although such dyes are somewhat light-sensitive, it does not make a great deal of difference in the dyeing of heavy cotton goods, such as flannels or cotton felts, because such goods seldom are exposed to sunlight. Commercially the direct or developed dyes would be too expensive. In the leather industry tannic acid is limited to the laboratory and to the preparation of expensive leathers. Another way in which it will tend to become important is in the clarification of beer. Often beer develops a sediment on standing due to the settling of the colloidal matter, a process which can be accelerated by the addition of tannic acid and proper treatment. This same procedure has been applied to the clarification of other beverages and flavoring extracts.

LACQUERS

One of the prime economic productions of the Anacardiaceae is the Oriental lac or lacquer. Unlike the various varnishing veneers of Western Europe, lacquer, properly so-called and as used in China and Japan, is a natural product, the sap of the tree, *Rhus vernicifera* DC., and to a lesser extent, of *Rhus succedanea* L. Of the industrial arts of China and Japan, lacquering seems to be the most characteristic.

The making of a fine specimen of lacquered art is an elab-

orate process, with fifteen to twenty layers of lac, each carefully dried before adding the next, being placed on the object to be covered (usually wood). The final surface then is variously carved, painted, or inlaid, the process often requiring many years for completion (7).

The trees, which are indigenous to China and have been cultivated in Japan for at least thirteen centuries, are tapped at about the age of ten years, lateral incisions being made in the bark and the running sap collected during the months of June to September. Branches an inch or more in diameter are also tapped, while the smaller ones are cut off, soaked in water for ten days, and the sap collected to produce a lacquer of particular quality for specific purposes. The process kills the tree, but the wood, when of sufficient size, is utilizable in carpentry. From the roots several shoots spring up which become available for the production of lacquer after about six years, and the operation can be thus continued for a considerable length of time before the tree is exhausted. The sap, when extracted, is white or grayish in color and about the consistency of syrup; on exposure to air it turns yellow-brown and then black. It is strained through hempen cloth to remove physical impurities, after being pounded and stirred in shallow wooden tubs, to give it uniform liquidity. It is then slightly heated over a slow fire or in hot sunshine and stirred again to evaporate excess moisture, after which it is stored in air-tight vessels. Lacquer is an irritant poison, but workers in the industry seem to become immune. Those not so immunized may be painfully poisoned by handling the lacquered articles.

The export of lacquered wares from Japan in 1932 was 1,195,000 yen (14). The United States is the greatest importer of the ware, in 1931 receiving 21 per cent of the total Japanese export and in 1932 46 per cent.

In Burma there is a lacquer industry of considerable importance. Here the resinous juice is from a species of Melanorrhoea. Articles of Burmese lacquer are naturally black, but the last few coats are usually colored with vermillion, which gives a dark red color. An important industry has grown up at Pagan. In Mandalay and elsewhere in Upper Burma the oleo-resin is thickened with a carefully prepared rice husk or cow-dung ashes

to the consistency of putty. This is used for ornamentation of boxes, thrones, and other decorative wares.

The production of lacquer is not limited to *Rhus vernicifera* DC., *Rhus succedanea* L., nor Melanorrhoea, for the sap of many of the poisonous genera of the Anacardiaceae, particularly "Toxicodendron," has the property of becoming black and drying into a durable varnish, a fact early pointed out by Miller (1752) in the sixth edition of his *Gardener's Dictionary:*

> 6. TOXICODENDRON *foliis alatis, fructu rhomboide. Hort. Elth.* Poison-tree with wing'd Leaves, and a Fruit shap'd like a Rhombus.
>
> This Sort of Poison-tree is not only a Native of *America,* but grows plentifully on the Mountains in *Japan,* where it is called *Fasi No Ki;* and from this Tree they extract one Sort of their Varnish or Lacca, which they use for japanning their Utensils: but this is not their best Kind of Varnish, that being made of the Juice of another Tree, which is also very poisonous, and nearly allied to this; and from which some Writers think it differs only by Culture.
>
> The Juice of this Tree is milky, when it issues out of the wounded Part; but soon after it is exposed to the Air, it turns black, and has a very strong fetid Scent, and is corroding: for I have observed, on cutting off a small Branch from one of these Shrubs, that the Blade of the Knife has been changed black in a Moment's time, so far as the Juice had spread over it; which I could not get off without grinding the Knife.
>
> As this Tree is very common in *Virginia, Carolina,* and *New-England,* it would be well worth the Inhabitants Trial, to make this Varnish.

VARNISHES AND OILS

In India the black acrid oil, cardol, from *Anacardium occidentale* L. is used as an oil or varnish for protecting books, furniture, and various household items from ants and other insects. In Goa it is used for tarring boats and for preserving fish-nets and lines. Dr. M. T. Harvey, of the A.D. Little Co., has studied the removal of the poisonous qualities from the oil in the pericarp of the cashew nut, adapting it for use as a varnish. The products, under the commercial name of "harvel," have the properties of Japanese lacquer and those of ordinary varnishes. These products are used in painting cement surfaces subjected to continual wetting, and for coating metal, wood and concrete where corrosive influences are great. One of the products is used as a binder for the manufacture of heavy-duty brake blocks such as are used in motor buses. Another product is used as a binder for public-

address system horns which are said to be the only 100 per cent moisture-resistant horns on the market (6).

The oil or waxy material from the berries of *Rhus vernicifera* DC. and *Rhus succedanea* L., in common with most of the "Toxicodendrons," contains much wax. The wax, particularly of *Rhus succedanea* L., which is of medium quality between beeswax and ordinary vegetable tallows, is sold as Japan wax and is much used in the manufacture of candles. The crude oily material is used in the adulteration of tung oil.

The turpentine pistachio or cyprus turpentine tree (*Pistacia Terebinthus* L.) of the Mediterranean region, after having incisions made in the bark, produces a clear, tenacious turpentine. Although it has the same properties as most turpentines, it is now little used because of its scarcity and consequent high price.

Pistacia Lentiscus L., also of the Mediterranean region, yields mastic or mastiche, which is a rather pleasant-tasting resinous exudate from the branches. It was formerly an official drug used in the form of an emulsion as an astringent and diuretic for debility of the stomach, dysentery and cutaneous discharges. However, it is now seldom given internally as it is regarded as devoid of any therapeutic value. It is still employed to fill cavities in the teeth and chewed to sweeten the breath, but its chief use is in the arts, in lithographic work, and particularly in the preparation of varnishes. In the Indian bazaars mastic, obtained from *P. mutica* Fisch. & Mey. and *P. khinjuk* Stocks., is sold. The better qualities are purchased in the European markets under the names of "East Indian" or "Bombay mastic." *Schinus Molle* L. yields a similar resin which is called the American mastic.

NOTE: The above article was prepared in the Museum of Economic Botany of Harvard University and at the Missouri Botanical Garden. In addition to the collections of these two institutions much information was obtained from various books and articles. The most important of these are listed below.

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HERMAN R. SWEET,
FRED A. BARKLEY.

ANOTHER DROUGHT WARNING

The special gardening problems brought about by a protracted dry period seem quickly forgotten with the advent of slight rains and cooler weather. The requests for information addressed to the Garden indicate that in so far as trees and shrubs are concerned, few growers are aware of the need of supplying water during this winter. Most requests, accompanied with a specimen for diagnosis, are for the name and control of the insect or disease causing a dying condition. That lack of water may cause death, long after the heat wave has passed, seems preposterous especially since everyone has practiced some sort of irrigation during the summer.

Trees and shrubs growing in this vicinity are accustomed to a short heat wave and drought each summer. During this time the water stored in the roots, trunk, and branches must supply all requirements. The past few years have amply demonstrated the adaptability of woody plants to changed water conditions. However, there comes a time—not easily predicted—when all reserves

are exhausted and death follows. Even small trees may become too desiccated to absorb water long before death of the top occurs. Large trees, both deciduous and evergreen, may require three years to consume the moisture stored in the trunk. Death is apparent when the foliage dries or the branchlets shrivel. Yet the root system, for many months past, may have been incapable of absorbing moisture.

Schematically, the present relation of soil moisture to a tree is shown in fig. 1. The region immediately around the trunk is

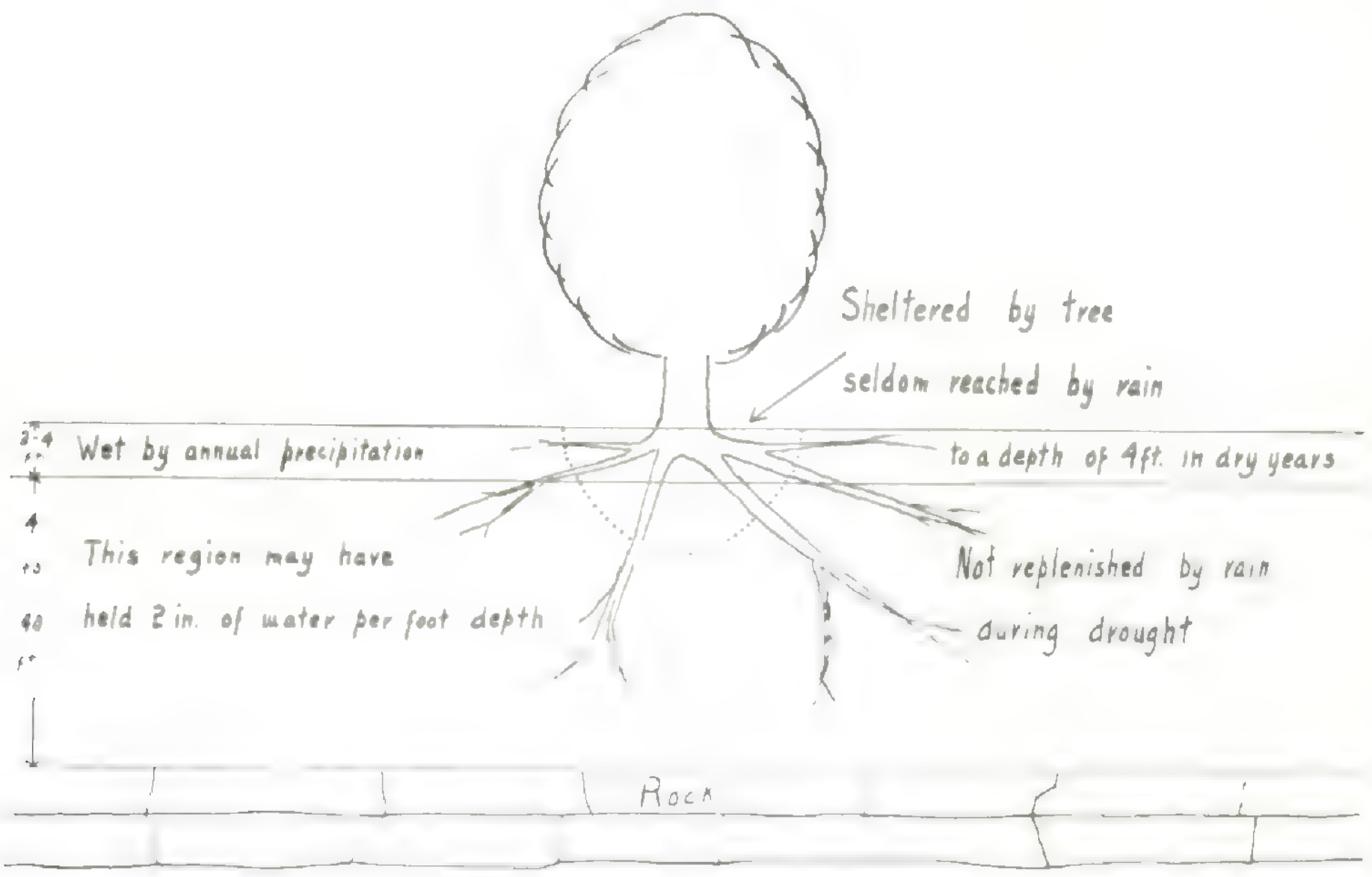

Figure 1.

sheltered from rain by the tree itself and is generally dry. This is particularly true for evergreens. A shallow layer not exceeding four feet in depth is wet by the annual precipitation, and whatever water is accumulated here must supply the tree throughout the year. Below this is a zone of soil, varying in depth but essentially a water reservoir, which in normal years supplies the bulk of the moisture requirements. However, the past six years have completely exhausted this zone, leaving no reserve for large trees.

Conditions in the St. Louis region are now very serious. As early as 1930 a moisture determination of soil in the Garden showed

only 3.5 per cent at thirteen feet. Such small amounts are present in even air-dried soil and are known as hygroscopic water. It exists as a microscopic film around each soil particle and therefore is not available for plant growth. A recent test gave 10.4 per cent moisture at six inches and 6.5 per cent at twenty-four inches under a grass cover. Under a plowed fire-lane, percolation had raised the supply to 10.1 per cent at twenty-four inches, a clear indication of the effects of cultivation on water percolation. The water-holding capacity of this soil is placed at about 25 per cent, which is approximately two inches per foot depth. The wilting coefficient-point at which plants show distress is about half of that, or 10 to 12.5 per cent. Thus at the present time there is no moisture available for plant growth, a factor which will contribute considerably to what will be termed next spring as "winter injury."

It is recognized that a diagnosis is of little value unless a remedy can be suggested. It is of prime importance, first of all, to supply water by irrigation. This must be done before active growth begins in spring. Unless the rains of winter and spring are as frequent and abundant as they have been scant and infrequent during the past several season, trees and shrubs will emerge from dormancy next spring with no better outlook for rapid growth than they had late last summer.

After water has been supplied either through rains or irrigation we are concerned with methods of retaining it and preventing needless evaporation. The very simplest method for the gardener is mulching. As much more might be said as has been said regarding mulching and mulching materials, but for the purpose of this article it is sufficient to say that any mulch is better than none.

A. P. B.

NOTES

Mr. L. P. Jensen, Manager of the Arboretum, has been re-elected president of the Henry Shaw Gardenway Association.

The October number of *Annals of Botany* (**50:** 759-766) contains a paper by Dr. Robert E. Woodson, Jr., Research Assistant

to the Garden, entitled "Observations on the Floral Fibres of Certain Gentianaceae."

On November 16 the "Henry Shaw Home" (Old Residence) at the Garden was described over Radio Station KSD, the third of a series of historical programs describing "old landmarks in the growth of St. Louis."

Mr. Fred A Barkley, graduate student in the Shaw School of Botany, spoke before the history of science section of the Academy of Science of St. Louis, November 27, his subject being "A Résumé of the Use of Drugs in the Treatment of Disease."

Mr. G. H. Pring, Superintendent of the Garden, spoke before the West End Kiwanis Club, at noon, December 16, on "The Romance of the Plant World"; and in the evening before the Men's Club of Peters Memorial Church, on "Jungle Experiences in Colombia, South America."

Mr. G. H. Pring, Superintendent of the Garden, acted as one of the judges at the Regional Flower and Garden Show of the Society of American Florists, at Wichita, Kansas, November 17-18. On November 17 he gave a talk, illustrated with colored moving-pictures, before the Associated Garden Clubs of Kansas, on "The Missouri Botanical Garden."

Among the recent visitors to the Garden library and herbarium were Miss Bonnie Templeton, Botanist at the Los Angeles Museum, Los Angeles, California; Dr. E. E. Naylor, Assistant Professor of Botany, University of Missouri, Columbia; Mr. J. C. Shirley, Head, Department of Biology, Phillips University, Enid, Oklahoma; Dr. Robert W. Webb, Principal Cotton Technologist, United States Department of Agriculture, Washington, D. C.; and Dr. W. H. Emig, Associate Professor of Biology, University of Pittsburgh, Pittsburgh, Pa.

Mr. L. P. Jensen, Manager of the Arboretum, has given the following talks during the past month: "The Henry Shaw Gardenway," before the midwest section of the National Conference of State Parks, November 13, at the Coronado Hotel; "The Missouri Botanical Garden Arboretum," November 15, before the same group when they were guests of the Garden and the Henry

Shaw Gardenway Association at the Arboretum; "The St. Louis Gardeners and Their Association," before the Greater St. Louis Association of Gardeners, at its 20th anniversary banquet, Century Boat Club, November 14.

Dr. Edgar Anderson, Geneticist to the Garden, lectured at the December meeting of the St. Louis Horticultural Society, December 4, on "Plant Hunting in the Balkans."

Two outstanding winter-blooming shrubs can now be seen in all their glory in the Garden greenhouses, reflecting Christmas cheer through their brilliant scarlet flowers and bright green foliage. *Euphorbia fulgens,* or scarlet plume, is a conspicuous feature of the cactus house during the holiday season. As a specimen plant it is ideal. Each slender stem bears a gracefully drooping plume of bright orange-scarlet flowers (really bracts) which make effective decorations, and, because of their keeping qualities, are unsurpassed for cut flowers. In the coffee house the showy red *Malvaviscus grandiflorus* accentuates the Christmas spirit. This tender shrub from the warmer parts of Texas and Mexico blooms profusely and is destined some day to become a popular winter pot-plant.

STATISTICAL INFORMATION FOR NOVEMBER, 1936

GARDEN ATTENDANCE:
Total number of visitors 47,285

LIBRARY ACCESSIONS:
Total number of books and pamphlets bought 26
Total number of books and pamphlets donated 236

PLANT ACCESSIONS:
Total number of plants and seed packets received as gifts 57

HERBARIUM ACCESSIONS:
By Purchase—
Bush, B. F.—Plants of Missouri, Arkansas and Oklahoma 447
Erichsen, C. F. B.—"Deutsche Lichenen," Halbzenturie, 9 und 10, Nos. 401-500 100
Weatherby, C. A.—Plants of Juan Fernandez Islands, collected by Charles Bock 14
By Gift—
Barkley, Fred A.—Plants of Missouri, Illinois, etc. 27
Berry, Edward C.—*Peltigera* sp. from Missouri 1
Dougan, L. M.—*Lemna minor* Linn. from Illinois 1
Drushel, J. A.—Plants of eastern United States and Mexico .. 139

Keck, David D.—Plants of California	31
Lodewyks, Maude C.—Plants of Missouri and Illinois	15
Lundell, C. L., by R. E. Woodson, Jr.—Plants of British Honduras	28
Moore, D. M., by E. Anderson—Plants of Arkansas	3
Seibert, Russell J.—*Riccia fluitans* and *Salvania natans*	2
Shirley, J. C.—Plants of Oklahoma	121
By Exchange—	
Hapeman, H.—Plants of Nebraska	76
By Transfer—	
Anderson, E.—*Synadenium arborescens* Boiss. from Horticulture	1
Fairburn, David C.—*Lycoris radiata* Herb. from Horticulture	1
Pring, George H.—Orchids from Horticulture	5
Field Work—	
Lodewyks, Maude C.—Plants of Missouri and Illinois	3
Total	1,015

Index to Illustrations

PAGE

Commemorative tablet at main entrance to the Garden..... 1
Commemorative tablet on former city residence of Henry Shaw.... 3
Commemorative tablet on former country residence of Henry Shaw.. 4
Commemorative tablet on Museum..... 6
Greater St. Louis Flower and Garden Show, rhododendron and azalea garden..... 9
Greater St. Louis Flower and Garden Show, centre panel of Garden orchid display 11
Greater St. Louis Flower and Garden Show, orchids from Sir Jeremiah Colman collection, shipped in full flower from England.. 12
Chrysanthemum Show, 1935..... 14
Yeasts, propagation of, by budding..... 45
Fern, life cycle of a..... 46
Propagation of plants from cuttings....49, 50, 54, 55, 57, 61, 62, 70, 72, 75
Propagation of plants by offsets and division of rhizomes..... .....70, 72, 73, 85, 86
Propagation of plants by runners and layers..... 75
Propagation of plants by tip layering and continuous layering..... 76
Propagation of plants by air layering..... 77
Propagation of plants by mound layering..... 78
Propagation of plants from bulbs, bulblets, bulbels, and scales..... 79
Propagation of plants by tubers..... 81
Propagation of plants by means of roots.....83, 89
Propagation of plants by means of leaves..... 85, 87, 89
Pine trunk, cross-section of, showing decrease in annual growth, resulting in death..... 95
Black walnut, growth of, during two dry seasons..... 95
Pinus austriaca, annual height increase of..... 97
Branches of trees showing annual growth of underfed trees, and effect of fertilizer..... 103
Post-hole method of fertilizing trees..... 104
Fertilizer dosage, how calculated..... 106
Trees, types of..... 107
Feeding roots of trees, showing placing of fertilizer..... 108
Punch-bar method of fertilizing trees..... 109
Pressure feeding gun, operation of, in fertilizing trees..... 110
Pressure feeding gun, diagram of..... 112
Migratory trees.....120, 121
Desert palms, avenue of, in Arizona..... 125
Washingtonia filifera at the Garden..... 125
Terrapin scale, larvae of, beginning to crawl..... 127
Henry Shaw, 1835..... 139
Main gate and lily pools..... 141
Missouri Botanical Garden, airplane view of..... 142
Dendrobium fimbriatum var. *oculatum*..... 144
Orchids, Dancing-girl..... 145
Orchids: Cymbidium hybrid seedlings; one of orchid seedling houses at the Arboretum..... 146

Lotus, sacred, of India 148
Pleiospilos simulans, a mimic plant 152
Stapelia gigantea, the giant carrion flower of South Africa 152
Economic garden, central path 153
Iris garden 154
Old residence and mausoleum grounds, winter view of 156
Missouri Botanical Garden in 1875 158
Missouri Botanical Garden, map of ..... following 162
Extreme heat, effect of, on plants: *Cattleya labiata*, *Anthurium Veitchii*, *Trichopilia suavis*, and *Dendrobium nobile* 174, 176
Lycoris squamigera 185
Mausoleum grove, view in 187
Textures, a study in: gill-over-the-ground, lily-turf, and Baltic ivy .. 189
Cacti: sea-urchin, lace, and pincushion 195
Neomammillaria Wrightii 201
Soil moisture, relation of, to a tree trunk 230

General Index

Figures in *italics* refer to page numbers of plates and cuts.

A

Acalypha, propagation by leaf-bud cuttings, *75*, 90
Acer saccharum; drought and heat damage to, 164, 167; moisture and temperature of trunks, 171
Achras Sapota, 151
Administration Building, 155; commemorative tablet on, *3*
Aesculus glabra, branches of, showing annual growth of underfed, and effect of fertilizer, 102, *103*
Agaves, 151
Agave utahensis, 207
Ailanthus glandulosa, 223
Airplane view of Missouri Botanical Garden, *143*
Aleurites, 151
Aloes, 150; propagated by suckers, *83*
Amaryllis: propagation of, *79;* hardy, 185
Amaryllis Hallii, 186
Amateur: free-blooming cacti for the, 194; winter courses in gardening for the, 208, advanced course, 210, elementary course, 208
"Ambatjang," 219
"Amra," 219
Anacardiaceae, A most useful plant family, 216
Anacardium occidentale, 220, 227
Anderson, Dr. Edgar, activities of, in 1935, 22
Annual bequests, 20
Annual flower sermon, 20
Annual report: of the Director, 1; of research and instruction, 20; of herbarium, 33; of library and publications, 36
Anthericum, offsets of, *87*
Anthurium increased by layering canes, *75; Veitchii,* effect of extreme heat on, *174*
Apprenticeships at Garden in 1935, 26
Arboretum, Missouri Botanical Garden: in 1935, 17; drought and heat damage at the, 163; new entrance at, 17; nurseries at, 17, 172; orchid seedling houses at, *146,* 147; orchids at, 17; winter injury to trees and shrubs at, 132
Arizona; northern, topography of, 205; southern, palms in, 123, *125*
Aroid house, 147
Artemisia "Silver King," 206; *tridentata,* 206
Ash: moisture and temperature of trunk, 171; white and blue, effect of drought and heat on, 164, 168
Astrophytum asterias, 194, *195*
Atriplex canescens, 205
Attendance, Garden, for 1935, 16
Azalea mollis, 16
Azaleas, 16; at Greater St. Louis Flower and Garden Show, 8, *9;* drought and heat damages to, at Arboretum, 173

B

"Bachang," 219
Back-yard gardens, 154
Balboa, Canal Zone, Tropical Station at, 19, 23
Balsa tree, 151
Bananas in main greenhouses, 149
Bao Musondo, 220
"Bauno," 219
Beech, copper, 149
Begonia, leaf-bud cuttings of, *85,* 88, 90; propagation by tuberous roots, 86
Bequests, annual Garden, 20
Betula alba, 173
"Binjai," 218
"Bo-dark," 157
Botanical orchids, effect of extreme heat on, 175

Botany, field, a six weeks' course in, 114
Bouea burmanica, 220
Boys' Camp at Arboretum, 17
Brahea, 123
Bromeliad House, some plants in, 147
"Brooding" scale insect, some notes on a, 126
Bryophyllum, leaf-bud cuttings of, *85*, 88; viviparous leaves, *87*, 88
Buckeye, effect of fertilizer on, 102, *103*
Bulbs, propagation of, 80: by bulblets, *78*, 82; by notching, *78*, 80; by scales, *78*, 82; by scooping, 80
Bulletin: discontinuance of free distribution of, 215; notice of importance to readers, 215
"Bumbum," 219
Bumelia lanuginosa: as a garden tree, 168; temperature and moisture in trunk, 170, 171
Burro-brush, 208
Buxus sempervirens, 16

C

Cacti, 7, 151; free-blooming, for the amateur, 194
Cactus; barrel, 151, 205; hedgehog, 196; lace, *195*, 196; pincushion, *195*, 196; prickly pear, 203, 205; saguaro, 153; sea-urchin, 194, *195;* twisted-rib, 194
"Caja Manga," 219
"Cajazada," 219
Calla tubers, propagation by division, *81*
Canna, rhizome cuttings of, *70*
Carnegiea gigantea, 124
Cardol, 227
Carrion flower, *152*, 153
Carya ovalis odorata, moisture and temperature of trunk, 171; *ovata*, branches of, showing annual growth of underfed, and effect of fertilizer, 102, *103*, moisture and temperature of trunk, 171
Cashew, 220
Cattleya labiata, effect of extreme heat on, *174*, *176*, 177; *Mossiae*, 177; *Trianae*, 177
Cattleyas, effect of extreme heat on, 175, 177
Cedar, red, on limestone glades, 164
Celtis pumila, 169
Century plants, 151
Ceratostigma plumbaginoides, 69, 193
Chamaebatiaria Millefolium, 207
Cherries, Japanese, at Arboretum, 17, 173
Chincherinchee, 7
Chickweed, eradication of, 16
Chicle tree, 151
Chittim-wood, 164; effect of drought and heat on, 168; temperature and moisture in trunk, 171
Chrysanthemum show in 1935, 10, *14*
Chrysanthemums, Korean, 13
Cholla tree, 203
"Ciruela," 219
Cissus sicyoides var. *Jacquini*, 6, 150
Citrus house, 147
Cliff-rose, 206
Coelogyne ramosissima, 208
Coffee plantation in main greenhouse, 149
Cold weather of 1936, effect of, on trees and shrubs, 130
Color pigments from Anacardicaeae, 224
Colman, Sir Jeremiah, orchids from collection of, at Greater St. Louis Flower and Garden Show, 10, *12*
Colorado River, 205
Commemorative tablets at Garden, *1*, *2*, *3*, *4*, *6*
Comocladia integrifolia, 220
Conifers, effect of drought and heat on, 173
Conservatories, main and exotic ranges, 5
Corms, propagation by, 82
Cotinus, 217, *americanus*, 224; *Coggygria*, 223

Course in field botany, a six weeks' course in, 114
Covillea tridentata, 205
Cowania Stansburiana, 207
Creosote bush, 205
Crop plants in economic garden, 154
Curriers' shrub, 217
Cuttings: propagation by leaf, *85*, *87*, 88; root, 84; leaf-bud, *85*, 90; stem, 48, *49*, *50*, *54*, *55*, *57*, *60*, *71*; hard-wood, 60, *61*, *62*; operations in making, *54*, *55*; pots, cases, benches for, *49*, *50*, 51, 52; rooting medium for, 51; soft-wood, 56, *57*; temperature, moisture, light for, 52; tools, accessories for, 53; of woody plants, 59
Cycad-fern house, 6, 150
Cycas revoluta, 150
Cymbidium: hybrid seedlings four months old, *146*; effect of extreme heat on, 177
Cyperus propagated from head of leaves, *89*, 90

D

Dahlia, propagation by division, *83*, 86
Damage, heat and drought, at tne Arboretum: to forest trees, 163, to plantations 172
Dancing-girl orchids, *145*
Day-lilies, 157
Degrees in Shaw School of Botany in 1935, 26
Dendrobium fimbriatum var. *oculatum*, *144*; *nobile*, effect of extreme heat on, 175, *176*; *Phalaenopsis* and *thyrsiflorum*, effect of extreme heat on, *175*
Desert plants in succulent house, 7
Director, forty-seventh annual report of the, 1
Displays, indoor floral, 8
Division, propagation by means of, *70*, *73*, 90
Dodge, Dr. C. W., activities of, in 1935, 21
Dogwood, flowering, at Arboretum, drought and heat damage to, 167
Dracaena, air-layered, *76*, 78
Dracontomelum dao, 220; *mangiferum*, 220
Drainage system, rebuilding of, 1
Drought: and heat damage at the Missouri Botanical Garden Arboretum, 163, to forest trees, 163, to orchids under glass, 173, to plantations, 172; another warning, 229
Dumb cane, 5, 148
Dyes, plants of Anacardiaceae used in, 222

E

Echeveria, offsets and leaf cuttings of, 88, *89*
Echinocereus papillosus, 196; *Reichenbachii*, *195*, 196; *Roetteri*, 202
Echinopsis, offsets of, *85*
Economic garden, 15, 153; central path in, *153*
Economic house, 6; some plants in, 151
Economic products of Anacardiaceae, 216
Elm tree; migrating, 122; which has moved laterally 2 feet and also settled, *120*, *121*; taken from old ground level, showing degree of settling, *121*
Elms, American and slippery, drought and heat damage to, 167
Eulecanium nigrofasciatum, 126
Euphorbias, 7, 17, 153
Experimental houses, 7

F

Feeding the shade trees, 95
Fellowships in Shaw School of Botany in 1935, 23
Fern: life cycle of, 45, *46*; Boston, propagated by runners, 71, *75*
Fern and cycad house, 150
Fern-bush, 207
Fertilizer: use of, in 1935, 16; commercial, for orchids, 8; for trees, formula of, 98, 101, effect of, 102, *102*, method of calculating dos-

age, 101, 105, *106*, methods of application, 147, mixing, 99, region of application, 106, *108*, time of application, 100, results, 102
Field botany, a six weeks' course in, 114
Floral display house, description of, 143
Floral displays, indoor, 8
Flower sermon, annual, 20
Flower and Garden Show, Greater St. Louis, 8; rhododendron and azalea garden at, 8, *9;* Garden orchid display at, 10, *11, 12*
Flower Show of St. Louis Horticultural Society: fall, 10, spring, 10
Fraxinus americana, moisture and temperature of trunk, 171
Fruit: from Anacardiaceae, 217; trees, espaliered, 153
Funkias, 193
Fustic, 224

G

Gallic acid, 224
Galls used in tanning, 223
Garden, see Missouri Botanical Garden
Garden Show, Greater St. Louis Flower and, 8, *9*, 10, *11, 12*
Gardeners Banquet Fund, 20
Gardening for amateurs, winter courses in, 208, advanced course, 210, elementary course, 208
Gardenway, Henry Shaw, dedication of tablets along, 18
Gasteria leaf cutting, *87*
Geranium, 8; leaf-bud cuttings, *85*, 90; sucker on root, *83*
Gill-over-the-ground, 157, *189*, 192
Ginkgo biloba, 157
Gladiolus, 8; propagation of, *79*, 82
Graduates and Fellows in Shaw School of Botany in 1935, 25
Grand Canyon region, plant life in, 205
Grape vine, tropical, 6, 150
Grasses: ornamental, in economic garden, 154; used in winter treatment of roses, 13
Greater St. Louis Flower and Garden Show, 8; rhododendron and azalea garden at, *8;* Garden orchid display at, 10, *11, 12*
Greenhouses, main, some plants in, 149
Greenman, Dr. J. M., activities of, in 1935, 20
Ground covers: for St. Louis gardens, 186; in mausoleum grounds, 157, 188, *189*
Growth of shade trees, 95
Gutierrezia tennis, 205

H

Hackberry, effect of drought and heat on, 164, 169
Haematostaphis Barteri, 220
Hamatocactus setispinus, 194
Hawthorns infested with terrapin scale, 126
Heat: drought and, damage at the Missouri Botanical Garden Arboretum, 163; extreme, effect of, on plants, 163, on orchids under glass, 173, *174, 176*, on plantations, 172, on trees, 169
Heating plant at Garden, 2
Hedera helix var. *baltica*, 188, *189*, var. *sagittifolia*, 190
Herbarium: report of, for 1935, 33; accessions, 33; exchanges, 35; field work, 35; mounting and insertion of specimens, 35; use of, 36
Hickories: effect of fertilizer on, 102, *103;* moisture and temperature in the trunks, 171
Hosta japonica, 193
Hoya carnosa, 150
Hunter, Mr. A. A., death of, 19
Hyacinth bulbs, propagated by notching and scooping, *79*, 80
Hybridization of plants, 8

I

"Imbu," 219
Improvements at Garden during 1935, 1

Income, decreasing, of the Garden, 1, 215
Injury, winter: to trees and shrubs in St. Louis, 130, 232; at Arboretum, 132, at City Garden, 131
Ink, plants of the Anacardiaceae used for, 224
Insect, "brooding" scale, some notes on a, 126
Instruction, research and, in 1935, 20
Iris: propagation by divisions of rhizomes, 69, *70;* test garden, 15, *154,* 155
Irrigation for trees, 231
Isatis tinctoria, 149
Italian Garden, 15, 149
Ivy: propagation by continuous layering 76, *76; stem cuttings,* 72; Baltic, 16, 157, 188, *189;* English, 188; poison, 216; Russian, 188

J

Juglans nigra, branches of, showing annual growth of underfed, and effect of fertilizer, 102, *103*
Juniperus sp. 203; *communis,* moisture and temperature of trunk, 171
Juniper, moisture and temperature of trunk, 171

K

Kaffir bread, 150
Kapok tree, 151
Kentucky coffee-tree, effect of drought and heat on, 167
Knolls, 157
"Kuwini," 219

L

Lacquer: from Anacardiaceae, 225; industry in Japan, 226; in Burma, 226
Lannea acida, 220; *grandis,* 224
Lawns and nursery in 1935, 16
Layers: propagation by, 74; air, *75, 77, 78;* continuous, 76, *76;* mound, 78, *78;* serpentine, *75,* 76; simple, 74; tip, 74, *76*
Leaves: propagation by means of, 86; viviparous, *85, 87,* 88
Lectures, scientific and popular, by members of Garden staff during 1935, 30
Library and publications, report of, for 1935, 36; Garden publications, 40; new accessions, 39; statistical information, 41; use of, 37
Light for growing cuttings, 53
Lilies: increased by scales and bulbels, *79,* 82; plantain, 193
Lilium regale, 17
Lily pools, tropical, 139, *141*
Lily-of-the-valley, division by rhizomes, *73;* as a ground cover, 192
Lily-turf, *189,* 192
Limestone glades at Arboretum, 164; drought and heat damage to plants on, 165; moisture and temperature in trees on, 170
Linnean Garden, 13, 143
Linnean House, description of, 143
Liriope Muscari, 192
Lotus: pond, 148; sacred, of India, 148
Lycoris squamigera, 185, *185*

M

Magnolia glauca, 143
Maidenhair trees, 157
Main conservatories, 5
Main gate, 139; and lily pools, *141*
Mammillaria Wrightii, 202
Mangifera, 218; *africana,* 219; *altissima,* 218; *caesia,* 219; *foetida,* 219; *indica,* 218; *odorata,* 219; *sylvatica,* 219; *verticillata,* 219
Mango, 218
Maples, sugar: drought and heat damage to, 164, 167; moisture and temperature of trunk, 171
Mastic or mastiche, 228
Mausoleum, Henry Shaw's, 156; winter view of grounds and old residence, *156;* ground covers in, 186; view in, *187*
Medicinal Garden, 149
Melanorrhoea as a source of lacquer, 226

Mesembryanthemums, 150
Migratory trees, some, 119
Mimic plant, *152*
Missouri Botanical Garden: airplane view of, *143;* drought and heat damage at the Arboretum, 163; map of, *161;* tour of the, 139; winter injury to trees and shrubs at Arboretum, 132, at City Garden, 131
Moisture: determinations of, in tree trunks, 140; for growing cuttings, 52; tests concerning soil, 230; relation of, to tree, *230*
Mombin, 219; red, 219
Mulberries, paper, 157
Mulching trees, 231
Museum building, 150; commemorative tablet on, *6*

N

Neomammillaria, 196; *applanta,* 196; *Wrightii,* 201, *201,* unusual growth due to etiolation, *201*
Neomammillaria Wrightii, that elusive, 20
Nepeta hederacea, 192
Nitrogen as a factor in tree growth, 98, 99
Nurseries: at Arboretum, 17, drought and heat damage in, 172
Nuts: cashew, 220; pistachio, 221
Nymphaeas in tropical water-lily pools, 139, *141;* "St. Louis," 140

O

Oak-hickory forests at Arboretum, drought and heat damage to plants in, 166
Oak, chestnut, moisture and temperature of trunk, 171
Odontoglossum crispum, effect of extreme heat on, 175
Offsets, propagation by, 71, *84, 86*
"Ogivi," 219
Oil from Anacardiaceae, 227
Old residence, 155; commemorative tablet on, *4;* winter view of, *156*
Oncidium stipitatum, flowers of, arranged in a ballet, *145*
Opuntia Engelmannii, 209; *imbricata,* 203, *Whipplei,* 208
Orchards at Arboretum, 17; heat and drought damage to, 173
Orchids: blooming at Arboretum, 17; dancing-girl, *145;* display of Garden's at Greater St. Louis Flower and Garden Show, 10, *11, 12;* division of plants, *89;* effect of high temperatures, under glass, 173, *174, 176;* hybrids at Garden, 144, *144, 145, 146;* in floral display house, 143; one of houses, containing seedlings, at Arboretum, *146,* 147; seedlings of, four months old, *147;* Sir Jeremiah Colman collection, 10, *12;* treated with commercial fertilizer, 8
Ornithogalum thyrsoides, 7
Osage orange, 157
"Otaheite apple," 219
Outdoor planting at Garden, 13

P

Pachysandra, 191
"Pahutan," 218
Paint pigments from Anacardiaceae, 225
Palms: Chinese fan, 151; date, 150; desert, 123, avenue of, in Arizona, *125;* oil, 151; sentinel, 123; sugar, 151; tagua, 151; Washington, 123; weeping, 123
Palm house, plants in, 5
Panama: exploration in, by members of Garden staff, 20, 23; Garden tropical station at, 19
Pandanus, 7, 147
Papaw, effect of drought and heat on the, 167
Papayas in main greenhouses, 149
Paphiopedilums, effect of extreme heat on, 175
Pennisetum Ruppelii, 13
Peonies, propagation by division, 91
Periwinkle, 157, 191
Peyote, 151
Phosphorus as a factor in tree growth, 98, 99

Phytelephas macrocarpa, 151
Pine: cross-section of trunk, showing decrease in annual growth, *95;* pinon, 203
Pines at Grand Canyon, 206
Pinus austriaca: annual height increase of, 95, *97;* effect of starvation on growth rate of, 96; *edulis,* 203; *ponderosa,* 173; *Strobus,* 173
Pistachio nut, 221
Pistacia khinjuk, 228; *Lentiscus,* 223, 228; *mutica,* 228; *Terebinthus,* 221, 223, 228; *vera,* 221, 224
Pitcher plants, 148
Plant Curiosities House, 71, 147
Plant life in the Grand Canyon region, 205
Plant propagation, 45, 69: by division, 90; by leaves, 86; by roots, 84; by stems, 48, 69; of ferns, 45, *46;* of yeasts, 45, *45*
Planting, outdoor, at Garden, 13
Plantain-lilies, 193
Pleiospilos simulans, 153
Plum: blood, 220; "Mexican," 219
Plumbago, rhizome cuttings of, 69, *72*
Poinsettias, 13
Poisonous plants of the Anacardiaceae, 216, 221, 226, 227
Poplar, hard-wood cuttings of, *61;* propagation by root suckers, *83,* 86
Poppy, Oriental, root cuttings of, *83*
Post-hole method of fertilizing trees, *104,* 107
Potash as a factor in tree growth, 98, 99
Potato, tuber cuttings of, *81,* 84
Pressure feeding gun: diagram of, *112;* method of operating, *110;* use of, in fertilizing trees, 111
Pritchardia, 123
Privet: hard-wood cuttings of, *60;* California, as a hedge, 149
Propagation, plant, 45, *49, 50, 54, 55, 61,* 69, *70, 72, 73, 75, 77, 79, 81, 83, 85, 87, 89;* by bulbs, *79,* 80; by bulblets, *79,* 82; by corms, 78, 82; by division, *70, 89,* 90; by means of leaves, 86, cuttings, *85,* 88, leaf-bud, *85,* 90, viviparous, *85, 87,* 88; by means of roots, 84, cuttings from, *83,* 84, suckers, *83,* 86, tubers, *73, 81,* 84, tuberous roots, *83,* 86; by means of stems, 48, 69, stem cuttings, 48, layers, 74, *75, 76, 78,* offsets, 71, *75, 87,* runners, 71, *75*
Propagating pots, cases, benches, *49, 50,* 51
Pseudospondias microcarpa, 220
Published articles by members of Garden staff in 1935, 26
Punch-bar method of fertilizing trees, *104,* 107, *109*
Pyrogallic acid, 224

Q

Quebracho, 222; red, 222
Queen's bouquet, 10
Quercus Muhlenbergii, moisture and temperature of trunk, 171

R

Rain water, effect of, on plant growth, 8
Rainfall in 1936, 36
Redbud, effect of weather conditions on, 164, 167
Repairs at Garden during 1935, 1
Research and instruction in 1935, 20
Reynolds, Dr. E. S., activities of, in 1935, 22
Rhizomes, propagation by, 69, *70, 72, 73*
Rhododendron and azalea garden at Greater St. Louis Flower and Garden Show, 8, *8*
Rhododendrons at Arboretum, drought and heat damage to, 173
Rhodosphaera rhodanthema, 223
Rhus copallina, 223; *coriaria,* 217, 222; *glabra,* 223; *jaranica,* 223; *lancea,* 220; *pentaphylla,* 223; *Potaninii,* 223; *succedanea,* 225, 228; *typhina,* 223; *vernicifera,* 225, 228
River bank, portion of, after slide, showing trees transplanted, *120*
Rock garden plants, 148, 164

Roots, feeding, showing placing of fertilizer, *108;* propagation by means of, 84, cuttings, *83,* 84; suckers, *83,* 86, tuberous, *83,* 86
Rootstocks, propagation by, 69, *70, 72, 73*
Rose garden, 13; description of, 140; in economic garden, 154
Roses: hard-wood cuttings of, *61;* winter treatment of, 13
Rubber-plants, propagation of, by air layering, *77,* 78
Runners, propagation by, 71, *75*

S

Sage-brush, 205
Sago plant, 150
Saguaro, 124, 153
St. Louis gardens, ground covers for, 186
St. Louis Horticultural Society, spring flower show of, 10
Salt-bush, 205
Sansevieria: leaf cuttings of, *87;* variegated, division of, *87,* 90
Scale insect, "brooding," *127;* some notes on a, 126
Scales, propagation of lily bulbs from, *79,* 82
Schinopsis Balansae, 222; *Lorentzii,* 222
Schinus Molle, 228
Sea-urchin, 194
Sedum sarmentosum, 193
Seedlings, drought and heat damage to, 173
Selinicereus increased by stem cuttings, *72*
Semecarpus Anacardium, 220
Senecio confusus, serpentine layering of, *75*
Shade trees, feeding the, 95
Shaw, Henry, 153; in 1835, *139;* country residence of, in Garden, 155, commemorative tablet on, *4,* winter view of, *156;* Gardenway, dedication of tablets on, 18; mausoleum of, 186
Shaw School of Botany in 1935, 25
"Shinia," 223
Shrubs, winter injury to trees and, 130
Smoke-bush, 223
Snake grass, 157
Soil: for cuttings, 51; deficiencies causing starvation in trees, 98; moisture in, 229, relation of, to trees, *230*
Sorindeia madagascariensis, 220
South African plants, 7, 149
Spondias, 219; *cytherea,* 219; *lutea,* 223; *pinnata,* 219; *purpurea,* 219; *tuberosa,* 219
Spraying: for terrapin scale, 126; roses, 13
Spring flower show, 10
Stapelia, 153; *gigantea, 153*
Stapeliads, 7
Starvation in trees: effect of, on growth, 95; soil deficiencies causing, 98
Statistical information for December, 1935, 42; January, 1936, 66; February, 93; March, 116; April, 137; May, 160; June-August, 181; September, 199; October, 213; November, 233
Stilt plants, 7, 147
Stonecrop, 193
Stems: propagation by means of, 48, *49, 50, 54, 55, 57, 61, 62,* 69, *70, 72, 73, 75, 76;* stem-cuttings, 48, *49, 54,* 69, hard-wood, 60, *61, 62,* soft-wood, *55,* 56, of woody plants, 59; layers, 74, *75, 76, 78;* offsets, 71, *75, 87;* rhizomes, 69, *70;* runners, 71, *75*
Succulent house, 7
Suckers, propagation by means of, *83,* 86
Sumacs: effect of drought and heat on, 167; American, 223; Greek, 222; Portugese, 222; Sicilian, 222; Spanish, 222; Triest, 223; Venetian, 223
Sunshine, hours of, recorded in 1935, 19
Sweet-potato, stem cuttings of, *83,* 86
Sycamore: drought and heat damage to, 167; migrating, 122; still growing after migrating two feet downstream and settling about four feet, *120*

T

Tamarix africana, 223
Tank plant, 147
Tannic acid, 225
Tannins and dyes in the Anacardiaceae, 222
Temperature: and moisture determinations in trees, 169; effect of high, on orchids under glass, 173; effect of low, during winter of 1935-36, on trees and shrubs, 130, 229; internal, of trees, 169; proper, for growing cuttings, 52, 57
Terebinth or Terpentine tree, 217
Terrapin scale: observations on, 126; larvae of, beginning to crawl at 10:00 a. m., *127*
Textures, a study in, *189*
Tiger-lily, propagation by bulblets, *79,* 82
Tolmiea, viviparous leaves of, *85,* 88
Tools used in plant propagation, 53, *54*
Tour of the Missouri Botanical Garden, 139
Toxicodendron as a source of lacquer, 227
Trees: drought and heat damage to, at Arboretum, 163; effect of fertilizer on, 102, *102;* feeding the, 95; growth of, 95; mulching, 229; relation of soil moisture to, *230;* some migratory, 119; temperature and moisture determinations in, 169, 230; types of, 107, *107;* watering, during the winter, 231; winter injury to, 130
Trench method of applying fertilizer to trees, 107
Trichopilia suavis, effect of extreme heat on, *176,* 177
Trichoscypha Redingi, 220; *Reygaerti,* 220
Tropical lily pools, 139, *141*
Tropical Station, Balboa, C. Z., 19
Trustee's Banquet Fund, 20
Tubers, propagation by, *73, 80, 81,* 84
Turpentine pistachhio, 230
Twisted-rib, 194

V

Vandeae, effect of extreme heat on, 175
Varnishes from Anacardiaceae, 227
Vegetable ivory, 151
Veiled Prophet Queen's bouquet, 10
Vinca, stem cuttings, *72; minor,* 191
Violet, African, leaf cuttings of, *85*

W

Walnut, black: during two dry seasons, *95;* effect of fertilizer on, 102, *103*
Wardian case, use of, in propagating plants, *50,* 88
Washingtonia—a desert palm, 123
Washingtonia filifera at the Garden, 124, *125; robusta,* 124
Watering: cuttings, 52, *55;* orchids at Arboretum, 177; shade trees, 96, during the winter, 231
Watering needle, use of, in applying fertilizer to trees, 108
Water-lettuce, offset of, *75*
Water-lily: pools, 139, *141,* 149; propagation of: by offsets from tubers, *73,* by division of rhizomes, *73,* by leaves, 88, by tubers, *80*
Wax from Anacardiaceae, 228
Wax plant, 150
Winter: courses in gardening for amateurs, 208, advanced course, 210, elementary course, 208; injury to trees and shrubs, 130, at City Garden, 131, at Arboretum, 132; treatment for roses, 13; watering trees during, 231
Woad, 149
Woodson, Dr. Robert E. Jr., activities of, in 1935, 22

Y

Yan Min, 220
Yeasts, propagation of, 45
Yucca, 205; *baccata,* 207; *glauca,* 203, 205

SOME FACTS ABOUT THE GARDEN

The Missouri Botanical Garden was opened to the public by Mr. Henry Shaw about 1860. From that date to the death of Mr. Shaw, in 1889, the Garden was maintained under the personal direction of its founder, and while virtually a private garden it was, except at certain stated times, always open to the public. Although popularly known as "Shaw's Garden" the name Missouri Botanical Garden was designated by Mr. Shaw as its official title and in his will or in any of his writings he specifically referred to it as the "Missouri Botanical Garden." By a provision of Mr. Shaw's will the Garden passed at his death into the hands of a Board of Trustees. The original members of the Board were designated in the will, and the Board so constituted, exclusive of certain ex-officio members, is self-perpetuating. By a further provision of the will, the immediate direction of the Garden is vested in a Director, appointed by the Board of Trustees. The Garden receives no income from city or state, but is supported entirely from funds left by the founder.

The city Garden comprises 75 acres, where about 12,000 species of plants are growing. There is now in process of development a tract of land of over 1,600 acres outside the city limits which is to be devoted to (1) the propagation and growing of plants, trees, and shrubs, designed for showing either indoors or outside, at the city Garden, thus avoiding the existing difficulties of growing plants in the city atmosphere; (2) gradually establishing an arboretum as well as holding a certain area as a forest reservation, with the idea that possibly at some future time this may become the new botanical garden.

The Garden is open to the public every day in the year, except New Year's Day and Christmas—week days from 8:00 a. m. until sunset; Sundays from 10:00 a. m. until sunset.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Place, on the Sarah car line (No. 42). Transfer south from all intersecting lines.

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